BETWEEN US AND HUNGER

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C. MAYADAS
M.A., B.Sc. (Edin.)

GEOFFREY CUMBERLEGE

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TO THOSE WHO DESIRE TO SEE THEIR HOMELAND
STRONG AND PROSPEROUS, WHO WOULD GLADLY
GIVE ALL THEY HAVE IN THE CAUSE OF
FREEDOM FROM HUNGER AND WANT,
THIS BOOK IS DEDICATED

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To the staff of the Oxford University Press has fallen the difficult task of editing the manuscript, and this has been done with commendable perspicacity.

C. M.

PREFACE

THERE is anxiety in the air; not only because of the danger of another world war, but also because of the growing world population and what appear to be diminishing food supplies. India has special cause to worry; her population is growing so rapidly that unless something is done to make food production keep pace with the birth rate, the country's deficit production is bound sooner or later to have disastrous consequences. The man in the street, the clerk at his desk, the labourer at the loom and the professional people; all are affected by the present high cost of living, especially of food.

What follows in these pages is intended to help all these people, especially those of them who are deeply and sincerely interested in seeing India freed from hunger and want and from dependence upon costly imported food, to see light on a dark horizon. A brief analysis is attempted of the major causes of the present state of affairs and a way is indicated whereby the fundamental obstacles to increased production can be overcome. Had the problems discussed here been insoluble, this book would not have been written. Had they not demanded a new approach, again it would not have been written. But the administrators, politicians, professional men and women in every walk of life, and in particular the very large body of students from which will presently emerge the future custodians of the welfare of this great country, need an awakening. The eyes of all who wish India well must be opened to the possibility of making the country economically strong by means of a sound but inexpensive agricultural policy. Public opinion must be aroused as never before to the critical situation which the country faces today, the evidence of which should be convincing to all but the most indifferent, callous and short-sighted. Once aware of the danger, and given the will to work and the selfless desire to see our country freed from want, there is no reason why, in addition to producing enough for the needs of our growing population, we should not have a substantial surplus left for export. There is no reason why there should

be hunger and nakedness and no reason why our standard of living should not compare with that of other countries.

When after the fall of France and the disaster of Dunkirk in 1940, Britain's freedom was threatened by the greatly superior German air force, a handful of British airmen with a few war-planes, some of them completely outdated, faced almost certain defeat. But such was the spirit of those airmen that the Battle of Britain was won against overwhelming odds and not only Britain but the whole world was saved from fascist domination. Some of that spirit is needed in India today, for this country faces a worse fate than threatened Britain in the summer of 1940. Freedom from hunger and want demands the same self-sacrifice, courage and free services of every able-bodied son and daughter of India as that given in the cause of another kind of freedom. It demands firm and, if necessary, drastic action by the government in power. Many patriots gave their lives in the cause of political freedom: Is it too much to expect that they should put their shoulders to the wheel of progress; that they should join in their thousands the Land Army of India; that they should carry out the measures necessary to defeat the spectres of hunger and want in a spirit of selfless service? For this book attempts to show how our resources—public and private—can be mobilized to break the chains that bind India to poverty and degeneration. It shows how the continued wastage of the country's greatest national assets can be stopped and how the harmful prejudices bred by superstition and age-old tradition can be overcome.

Many Indian and overseas friends have for some years pressed the writer to produce a book incorporating his thirty-one years' experience in the Indian Agricultural Service. Since retirement he has been engaged in running a small farm of his own near Lucknow. This farm, when it was acquired, was mostly useless ravine land sloping rapidly down to a river. By anti-erosion measures and by the judicious use of manures, fertilizers and water, it is now an interesting proposition and grows good crops of cereals, roots, vegetables and fruit. Working as a small farmer among neighbours who are also small farmers, there is much to learn and, having been successful to the extent of winning a prize for wheat in the State crop competitions, without

having made any investment in the land which his neighbours could not afford, the writer has withdrawn his first resistance to his friends' suggestions. So here it is, a book which embodies his experience not only in service but in retirement, and for whatever it is worth, it is at the disposal of the country.

The treatment of each subject is by no means exhaustive. It errs in fact on the side of brevity, but a brevity with a purpose. So much has been said in recent years about the Indian food situation in journals and in the daily newspapers that the average person has become confused. What is wanted is a presentation of the subject in a concise and easily digestible form so that, whether the reader knows anything about farming or not, his interest will most certainly be aroused in this most pressing problem. An attempt has therefore been made in the pages that follow to present as true a picture as possible, in the first instance of the country's present economic situation and secondly of the ways in which the wastage of the nation's vast rural resources can be stopped. The appeal should not be to any one section of the nation, but to everybody who is interested in bringing about a change for the better.

Lucknow, C. M.
September 1953.

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CHAPTER ONE

THE GRAVITY OF THE WORLD FOOD SITUATION

PROFESSOR Dudley Stamp of the International Commission which is organizing a survey of the use of land throughout the world, has, amongst other people, expressed the opinion that food production is not keeping pace with the growth of the human family despite the advance of science. The rate at which this family is growing is alarming. Twenty million more mouths to feed each year or 60,000 to 70,000 more mouths demanding food as each day dawns, is a formidable prospect.

In the world today it is estimated that if we could evenly spread the world's population over its entire surface, each individual would have about fourteen acres. But the surface of the earth is not all productive. There are huge tracts that are too cold; others that are too dry and still others that are so mountainous or so rugged that they cannot produce food crops. If all the land capable of producing food was doled equally out to the people living on the earth's surface, each person would get about four acres. But if the land was well or scientifically farmed according to our present knowledge, it would only take about an acre to produce enough food to feed one person adequately.[1] In tropical countries where rainfall and heat favour plant growth, the yields of crops like rice can be very high, so that the produce of an acre can often feed more than one person. On the other hand in a country like India where about four fifths of the cultivated area depends solely on rainfall and is not irrigated, much of the area can yield only one crop a year. It is worth noting here that while India's population stood at 357 millions at the 1951 census, the cultivated area of the same period was only about 244 million acres. When it is considered that the rate of increase

[1] An estimate by Professor Dudley Stamp in a B.B.C. broadcast of 1952.

of India's population is of the order of 5 million souls per annum, a rough average of various recent estimates, and that in 1971 the country will have to feed some 462 million mouths, the enormity of the task of attaining self-sufficiency in food is at once apparent. This is more or less the position in other Asiatic countries as well.

The Food and Agriculture Organization in its *World Outlook* of 1950[1] stated that by 1951 the increase in world food production would be barely keeping pace with population growth and that this was likely in some of the regions where improvement was needed most. India is one of these regions.

Sir Alfred Chatterton states that 'Not only in India but in most of the densely populated regions of the tropics both in Asia and Africa, it is now generally recognized that there is a growing shortage of food, and that it is deficient in quality as well as in quantity. The margin of cultivation is steadily extending to poorer classes of land which yield crops of inferior nutritional value.'[2] He gives the following comparative statement of average yields in lb. per acre of cereals and sugar in seven countries.

	Rice	Wheat	Sugar
India	1,300	605	2,400
Japan	3,000	1,525	3,340
Egypt	2,800	1,245	3,380
Canada	—	1,530	—
Hawaii	—	—	18,800
Java	—	—	12,000
Great Britain	—	2,200	—

One conclusion from these figures is clear and that is that India is far behind the other countries in the list in per acre production of its main cereal crops of rice and wheat. Japan produces on an average some 2¼ times as much rice and Canada 2½ times as much wheat per acre as India does. The possibility of increasing India's per acre production of food crops substantially is of vital concern to the people of India and to the rest of the world. If, as Professor Dudley Stamp estimates,[3] one acre of scientifically farmed land is

[1] *World Outlook and State of Food and Agriculture, 1950* (The Food and Agriculture Organization, Washington D.C., U.S.A.).

[2] An article in *The Pioneer*, Lucknow, 23 March 1952.

[3] In his B.B.C. broadcast.

capable of feeding one person, and if all the 244 million acres under cultivation in India were to grow nothing but food crops, then out of India's present 357 million people only 244 million people would be properly fed, and the remaining 113 millions would have to be fed on imported food to keep them from starving.

By 1971, no less than 218 million people in India alone will face starvation. Can any prospect be more appalling? And can India afford to eliminate the cultivation of jute, cotton, tobacco, tea, coffee and other non-food crops altogether in order to have 244 million acres under food crops alone? At present the acreage devoted to the major non-food crops is about 19 million acres, and already there is a general clamour for more jute and more cotton. Sugarcane and all oilseeds, other than castorseed, have been classed as food crops for the sake of these calculations. If these crops were to be excluded, the area under food crops which would have to feed the 1971 population of 462 millions would be a mere 195 million acres or about 0·42 acre per person by that date. Whether the available acreage or a large part of it can ever be scientifically farmed remains to be seen. At present the available acreage very definitely is not farmed scientifically.

Turning now to the so-called old fallow or culturable waste land in India as typical of some other Asiatic countries, recent land utilization statistics quoted by the Government of India[1] show that 93 million acres are culturable waste or fallow land. Another 64 million acres are under current fallow. There is no definition to tell us how near to or remote from marginal land this comparatively large acreage of culturable waste land of 93 million acres actually is. Is it land which wholly or in part has been abandoned by the farmers because of bad farming practices causing heavy loss of fertility? Or is it land which has been largely scoured by soil erosion? In any case it is safe to assume that most of it needs special treatment before it can produce food crops economically. This treatment may possibly entail drastic and expensive soil conservation practices, including the application of heavy doses of organic manure such as

[1] *Land Utilization Statistics, Pre-war Average to 1948-49* (Ministry of Food and Agriculture, August 1951).

town compost, before the soil is ploughed up. In chapter six this question is discussed in some detail.

In any case, irrigation would be necessary to make the land produce what is expected of it, namely yields comparable with those obtainable say in China or Japan.

In India, the main cereal crops of wheat, rice and barley have for some years been rationed for the 40 million people who live in towns, but for the 317 million people in rural areas there is no rationing. India has, however, been importing food worth 150 to 200 crores of rupees (£112 to £150 million) each year and has also been subsidizing this food to the extent of 40 to 50 crores of rupees each year in an effort to keep price levels from soaring too high. In the budget presented to the Government of India on the 23rd of May 1952, the food subsidy was not to be maintained as it would entail an exchequer expenditure of Rs 60 crores and because 'if in addition to subsidizing milo, the price of food in industrial and other areas were to be given to the whole range of consumers, the cost would rise to about Rs 90 crores (£67½ million) a year'. Within a day of this announcement the prices of rationed cereals rose in the open market. It is yet to be seen what the consumer will have to pay for his cereals. Internal procurement of food grains has been none too satisfactory; drought and floods have played havoc over large tracts and the yield per acre of most cereal crops has fallen considerably since 1933-4, as the following official figures[1] will show.

Year	Acreage (thousands)	Production (thousand tons)	Yield per acre in lb.
1936-9 (av.) ..	183,753	50,019	663·6
1943-4 ..	192,065	51,655	602·5
1945-6 ..	197,537	45,736	518·5
1946-7 ..	195,829	46,143	532·9
1947-8 ..	191,537	48,244	564·2
1948-9 ..	207,300	47,849	521·8
1949-50 ..	215,994	49,685	515·2
1950-51 ..	212,450	45,489	479·7

[1] The figures in the first two columns are taken from *Area and Production of Principal Crops in India, Pre-war Average, 1943-44 and 1945-46 to 1950-51* (Ministry of Food and Agriculture, November 1951) and the last column is calculated therefrom.

If we examine these figures we find that the pre-war yields per acre are higher by no less than 184 lb. than those of 1950-51. During these years the acreage under cereal crops increased by no less than 28·7 million acres, and this was accompanied by a deplorable drop in per acre yields. In 1943-4 and every year since there has been a special effort to grow more food and the effort has apparently been successful in bringing more land under the plough, but completely ineffective in increasing the yield per acre. Whether this phenomenal drop in yields is the result of marginal land being put under the plough, or of soil erosion or deterioration caused by soil exhaustion, or is caused by combinations of these and other factors is difficult to say; but the position calls for the immediate and most serious attention of all who wish to see India self-sufficient in food supplies.

Not only has the yield per acre dropped, but disastrous consequences followed the 1947 partition of India. Internal strife in Burma had already stopped the export of some two million tons of rice to India and, with the creation of the State of Pakistan, India lost most of her valuable wheat- and rice-growing areas. In the wake of the terrible events of August and September 1947, came a phenomenally large influx of refugees from Pakistan into India. These millions of families, deprived of all their possessions, have added to the gravity of the food position, for they have to be fed on rationed food grains without being immediately able to assist in strengthening the country's food resources. Most of these unfortunate people have taken refuge in the large towns, imposing a heavy burden on the already severely taxed town rationing system.

This grave situation is intimately linked with another burden. India has the largest number of cattle of any country in the world. At least one half of her 177½ million cows, buffaloes and their kind are more or less useless either for milk production or as draft cattle. Religious sentiment is against cow slaughter and in consequence an enormous number of useless cattle feed on whatever they can get and much damage is done to growing crops by their roaming about the countryside. Thousands of bulls and cows have found their way into jungles adjoining cultivated land and

they are as fierce to deal with as any other wild animal. The farmers are powerless, and to these must be added an even larger number of deer (including blue bull), wild boar, porcupines, monkeys, rats, parrots, sparrows and ants. All this wild life is supported by whatever grows and is edible and generally it is the cultivated fields that are the main target of their depredations.

Fragmented small holdings, wanton wastage of valuable organic manurial material, unrestricted multiplication of weeds and pests, dangerous soil erosion, inadequate conservation and utilization of underground and other water resources, primitive agricultural accessories and an inadequate agricultural policy with an unsuitable organization to carry it out, all add to the difficulties of achieving self-sufficiency in food. That there are solutions to these problems which are causing so much distress and which are leading at least one Asiatic country to starvation or bankruptcy or both, will become apparent to the reader who follows this book. There is no reason why, if certain very urgent and necessary measures are adopted, India should not produce enough food to adequately feed 500 million people and more. Indeed, the situation is far from hopeless. The agricultural potential of India has not been fully exploited yet by a long way. But it requires a well-planned policy and strength of purpose to carry it out, to achieve not only self-sufficiency, but the abundance and prosperity that the export of surplus agricultural produce brings.

CHAPTER TWO

WASTE NOT, WANT NOT

An annual increase in population of 5 millions or more, an already inadequate acreage under food crops, and constantly decreasing production per acre, are not the only factors to trouble us. We also have to account for a scandalous amount of *preventable* wastage of soil, of soil food and of human food, in the field, in storage and cooked. Unless drastic measures are taken and taken very soon to prevent this criminal waste, no tightening of Indian belts will save the country from the dire distress towards which it is most certainly heading.

Land Utilization

Examining the position closely, let us see what the glaring instances of preventable waste actually are and how far one can reasonably estimate their extent. In 1951 the Indian Food Minister gave the following figures[1] indicating soil wastage: 'Out of our cultivable area of 400 million acres, 61 per cent is crop yielding; 16 per cent is current fallow; 23 per cent is cultivable but now *wasted*. Out of our total cultivable area 123 million acres *are being eroded or exhausted by primitive methods of farming*. Only 48 million acres are irrigated: the rest depends upon a freakish monsoon.' Only 61 per cent of the country's cultivable area can at present be regarded as providing for the country's needs of food and raw materials for industry and export. *Only 61 per cent*! In 20 years the population is expected to increase to 462 millions, 218 million souls of which will face starvation, and while this is happening, the country is wasting 39 per cent of its cultivable area!

To adequately feed 462 million souls in 1971, India will require as many acres of land. In reality she has got only 400 million acres of potentially productive land, 244 million

[1] K. M. Munshi: *The Gospel of the Dirty Hand* (a collection of the author's speeches), p. 132 (Ministry of Food and Agriculture, April 1952).

acres of which are already under cultivation. If the country could produce yields of rice comparable to those obtained in China or Japan and of wheat comparable to those of Canada, even 400 million acres would suffice for a population of 460 million people. But how are all the 400 million acres to be made adequately productive? The current fallows will tend to disappear under intensive cultivation and extended irrigation, but the 23 per cent of land which is cultivable but wasted, is quite another matter. Much of this is rich alluvial soil needing drainage, anti-malarial measures, anti-erosion measures and mechanized farming. All of it is capable of producing food and the raw materials of industry, and yet it is wasted. And this picture of wastage of the greatest of all our national assets is not complete without adding to it the fact that no less than 123 million acres are being either eroded or exhausted. Erosion is to soil what tuberculosis is to the human body. If checked in the early stages it can be cured, but if allowed to get a firm hold it kills. Yes, soil can be *killed* just as human life can be taken. The top layer of five or six inches of soil is the most valuable, because in it are millions of soil organisms busy creating plant food. The lower layers are not so rich, and as you dig deeper you come to the subsoil on which nothing will grow. In erosion, the top soil is the first to be swept away by natural forces, chiefly rainwater; and, if unchecked, erosion kills the productive power of the soil by removing from the field this top layer. Where erosion is apparent, the simple expedient of putting up some sort of resistance to the flow of rainwater is occasionally applied by intelligent farmers. But in the vast majority of cases, the erosion is almost invisible and requires systematic treatment. Of this, more later.

Land Fertilization

Losing soil productivity through preventable erosion is bad enough; but there are other and almost worse evils. One of these is the wastage of human and animal excreta, bones and ashes, and of all kinds of animal and vegetable organic matter. The main reason why the average yields of rice in China and Japan are more than double those of India is not that the Chinese or Japanese are better farmers

than are Indians or that their soils are richer, but that they conserve human and animal excreta for the soil. If Indian farmers were to get over their prejudice against handling night soil to conserve it for use as manure, and were to convert even a quarter of the cattle dung produced into compost with the help of urine earth and the weeds which abound in the rains, the resultant effect on the productive power of our soils might make all the difference between a starving India and an India freed from want.

India's production of cereals in 1951 was some 45 million tons per annum. We talk of a 7·2 million tons increase in production with the help of expensive irrigation schemes and the like, as a result of the Five Year Plan. If only a part of the money involved was to be spent on conserving all waste organic matter for the soil, India would probably be self-sufficient in food in a very short time and would quite possibly be exporting a surplus of her agricultural production in four or five years from the time that a country-wide drive was systematically put into effect. How such a step could be made effective, will be discussed later.

Apart from the wastage of night soil in our villages, there is a colossal wastage of town sewage, which should be scientifically treated and used on suburban agricultural land. The farmers of China and Japan have realized the value of this material, and in Europe and America there are numerous sewage utilization schemes in operation. India, whose need for increased food production is far greater and more urgent perhaps than that of any other country, is wasting this valuable source of national wealth and is instead spending vast sums of money on imported food, even then leaving her people underfed.

PESTS

It is seldom realized how great is the annual national loss of food due to the depredations of insects, rats and wild animals. It is difficult to estimate these losses and yet the food situation demands that a body of experts should tour the length and breadth of the country to make just such an estimate. In the insect world, while entomologists are busy fighting locusts and the smaller insect pests of field crops, white and black ants are also responsible for heavy losses, but

for these no effective remedy has yet been applied and no one seems to bother very much about them. White ants destroy the young roots of grain crops, often affecting the final yield by as much as 50 per cent. Black ants have been known to carry the ripe ears of wheat and barley into underground nests at the rate of about 20 lb. per acre, during and immediately after the harvest. As if it was not enough for the grower to suffer these losses in the field, other insects follow the grain into village and town storage space. Completely unsuitable methods of storage are responsible for much of the annual loss in foodgrains, and a computation should be made of this loss. The country's present output of cement is barely enough to provide for housing, but when the annual loss to the nation of valuable foodgrains has been estimated, perhaps the State will see fit to provide enough cement for proper food storage also, and will then make it a criminal offence to store grain by out-dated methods.

Rats are another serious pest to which adequate attention has not so far been given. There is perhaps no single pest that causes more damage to foodgrains in storage or to crops in the field. Thirty years ago, two Indian entomologists, H. S. Pruthi and M. A. Husain, in a bulletin[1] on the subject, considered that 800 millions was a modest estimate of India's rat population. This estimate, made by Kunhardt, has recently been exceeded by 300 per cent by Dr K. B. Lal, an eminent Indian entomologist, who now estimates that the rat population of India is about 2,400 millions. The two former entomologists estimated that a rat consumes about two ounces of grain per day. At that rate, if all the rat population had access to our foodgrains, we would have to live on non-cereals, because every ounce of the grain produced in the country would already be eaten up. Two thousand four hundred million rats would consume over 52 million tons of cereals per annum if each ate 2 ounces. Fortunately for us, not all rats have access to foodgrains, and Dr K. B. Lal rightly considers that while a full-grown rat will consume 2 ounces, a baby rat will consume much less. An average of 1 ounce per day is a fairer estimate.

[1] *Some Observations on the Control of Field Rats* (Bulletin 135 of The Agricultural Research Institute, Pusa, 1922).

The same authority considers that only about a tenth of the rat population has access to foodgrains. Even on this basis, the damage done is so great that if it could be prevented the country would be exporting and not importing cereals. To the actual grain eaten by rats must be added all that is otherwise destroyed; for apart from the big godowns 'there are innumerable houses and petty shops all over the country' which, says Dr Lal, 'are seldom talked about'.

The time has surely come for a concerted effort, in every state of the Union, to destroy as many rats as possible by every means and as soon as possible. Rat traps, rat poisons both solid and gaseous, and all other effective methods should be extensively used. The new community projects now being launched in the rural areas of India could play their part in rapidly reducing the population of this and other pests. In our towns, it should be made incumbent by law for every owner of a godown or grain store to effectively use all means as are prescribed by law, to destroy rats—not just once in a while, but every day till the menace disappears altogether. There is ample expert advice available.

There is no reason why fairly reliable estimates of damage done to food crops by other animal pests should not be reached by experts for each state of the Union. It would then be up to each state to secure the co-operation of the public by means of wide publicity in order to fight the menace. It is not necessary always to annihilate the pest. There are ways of dealing with the problem which need not upset the balance of animal life in Nature nor offend the sentiments of any section of the population. These are discussed in chapter four. It will be necessary for the experts to determine which of the insects, birds or beasts are to be regarded as seriously dangerous to food crops and to arrange them in order of importance. In some cases it may be found that the pest is also a predator, feeding on another pest. This may especially be the case with certain birds which feed on harmful insects. In destroying them, there may be the danger of upsetting the balance of nature. The problem will therefore need very careful handling.

In assessing the damage done to crops or to grain in storage, it should be remembered that apart from the actual consumption of human food by animals, there is a high

percentage of loss by wanton destruction. For example, if you watch monkeys feeding on the ears of green wheat, you will find that a number of ears and plants are left lying in the field, apart from those actually consumed. With the deer family, damage is done by the herds trampling down young plants and by their lying down on them. This is in addition to considerable destruction caused by their feeding on cereal crops. Wild boar and porcupine will dig up a field of potatoes, sweet potatoes or even a cereal crop, leaving many plants and tubers uprooted. Parrots, crows and other birds descending on a field of maize or millet in cob, will nibble here and there, scattering almost as much as they consume.

So much is taken for granted in rural areas that the damage done to crops by the pests mentioned here often passes unnoticed by the Indian cultivator. The growers' defence against the ravages of these pests is meagre. Driving away wild and tame cattle or deer when the damage has already been done, making noises to frighten away wild pig and porcupine at night or sitting up on a high perch in the middle of a field of millet or maize are well known practices in the villages. But they are ineffective. Certain pests such as the field rat and the ant do their extensive damage silently, and the villager does not trouble himself very much about them. He cannot see the danger to the nation's food supplies presented by the ever-increasing numbers of various animal pests. It is for officialdom to realize the danger and to take effective steps to reduce the damage to a minimum. The idea of utilizing a volunteer force of educated men and women in a Land Army to help to deal with this and other urgent rural problems, is an excellent one, but to have it on paper or to talk about is one thing and to organize it for action is quite another. Men and women must be organized into effective teams for each of the country's 700,000 villages. And a vigorous recruiting drive for this Land Army should be started now.

WASTE

Far too common examples of preventable waste are to be found at marriage feasts, club dinner parties, at the individual houses of the well-to-do, and in some public feeding

places. While the poor starve, many of us gorge ourselves with far more food than is good for us, wasting more than we eat. At railway stations and in restaurant cars, food is served far too liberally. It is usual for both rice and wheat to be served, even to people who do not normally eat rice at each meal. The practice of serving food in a large number of small receptacles is wasteful and should cease in the national interest. It is just as pleasant and far more economical for the customer to be told what is available, and for him to ask only for what he wants and knows he can eat. If cooked rice alone is wanted, there is no point in serving bread as well. In fact, it should be made an inviolable rule that no one will be served with more than one cooked cereal at any meal, and this should be enforced in all public feeding places, including hotels. The public should be subjected to a strenuous propaganda campaign in favour of economy, to which the politicians and the press should subscribe.

CHAPTER THREE

THE CONSERVATION OF SOIL WEALTH

Soil erosion is one of the manifest signs of soil mismanagement. The official estimate is that out of about 400 million acres of cultivable land in India, no less than 123 million acres are in the process either of soil erosion or of exhaustion caused by primitive methods of farming. Assuming that out of this area some 60 million acres are rapidly being put out of cultivation by erosion, the effect is that, with a potential grain producing capacity of a quarter of a ton per acre, 15 million tons of essential food are in the process of being lost altogether by erosion alone. Add to this another 15 million tons which could be raised on the remaining 63 million acres if saved from the effects of primitive methods of farming, and you have the astounding figure of 30 million tons of potential food being literally allowed to go to waste. This is roughly two thirds of the total yearly production of cereals in India.

No country, far less India, can afford to allow such staggering wastage as it must eventually lead to economic disaster. The pity of it is that there is a simple and straightforward remedy for soil erosion, but it is not being applied. This remedy is so convincing in results that the cultivator takes to it most readily. It is only a question of demonstration.

Daulbandhi

Consider the commonest type of soil erosion, namely the washing down of surface soil during rainy weather on fields which are not levelled or terraced. Taking India as a whole, it will be found that a very high percentage of the land which suffers erosion is land which slopes a few inches from one side of a field to another. There are seldom any terraces in the plains where the land slopes but slightly; neither is *daulbandhi*, i.e. the making of low earth barriers against the free flow of water on sloping fields, commonly practised. *Daulbandhi*, especially, is the simplest and most inexpensive

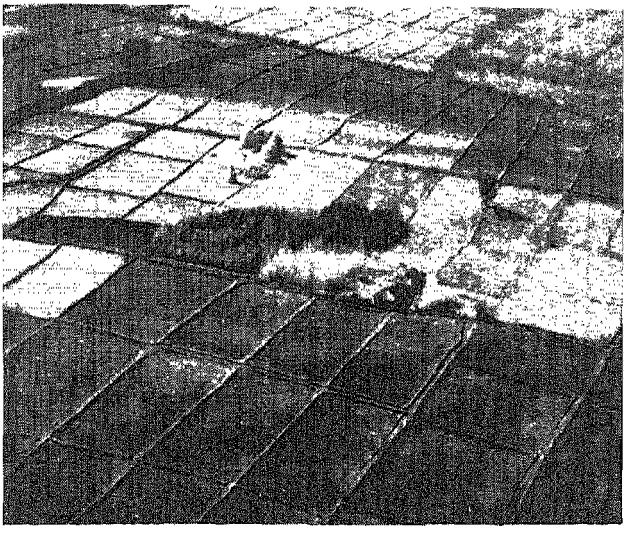
remedy for soil erosion and could be applied over the major part of the 60 million or so acres that are fast being lost by erosion. It consists of digging the earth in a line along the lower end of the field and making a barrier or low earth wall 15 to 20 inches high and as much in width at the base, tapering to the top. The barrier is then beaten by hand and sprinkled with water if necessary to consolidate it and prevent it being blown about by the hot winds preceding the rains. It is designed to hold up the water which brings down in suspension soil from the higher parts of the field, depositing the silt *within* the field instead of into the nearest tank, ravine or river. The field thus gradually becomes even, by a natural but gradual process of silting up the lower end, and its fertility is kept within its boundaries. The barrier stems the rush of water and prevents harmful erosion. While it is true that fertility is washed slowly down from the higher to the lower level, what really matters is that it is kept within the same field, and the higher yield in the lower part of the field caused by accumulated fertility compensates for that on the slightly denuded higher level. As the process continues and the field levels up, the yield tends to be uniform over the entire surface of it.

In 1942, the average cost of making these earth barriers was about three rupees an acre, and the system was, at that time, practised widely in the United Provinces. When the method was first introduced, a small cash prize of half the cost of making the *dauls* or barriers was offered by the Directorate of Agriculture, but this was soon withdrawn as demonstrations alone were found to sufficiently attract cultivators to the scheme. This simple but effective method of preventing sheet erosion of soil was not however advertised, as it should have been, throughout the length and breadth of India. The time has now come to make its adoption obligatory and for the panchayats to impose heavy fines on those who do not adopt it. It would take too long to carry out detailed surveys, but all members of agricultural extension services throughout India and all volunteers of the proposed Land Army should be trained to observe the flow of water on every field and to decide whether the introduction of *daulbandhi* is necessary. The early rains is the best time for this.

It will seldom be necessary to provide for any elaborate system of channels to take off surplus water; for where the slope is only a few inches, the water held up will soak into the soil almost as soon as it rises against the artificial barriers or *dauls*. During heavy rain, the cultivator must be in his fields in person to repair breaches in the barriers as and when they occur. This work can be facilitated with the co-operation of village panchayats.

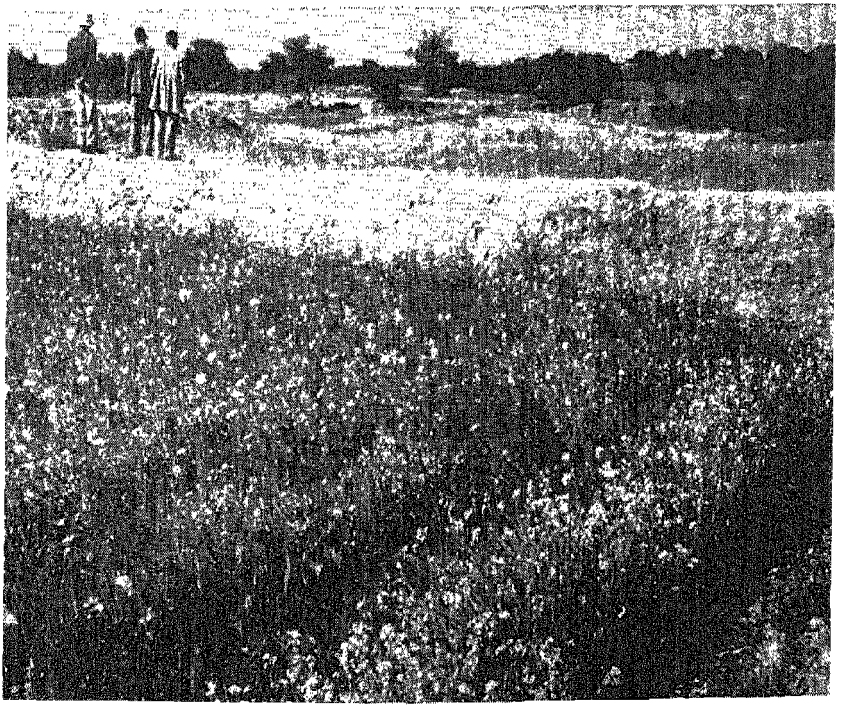
Bench Terracing

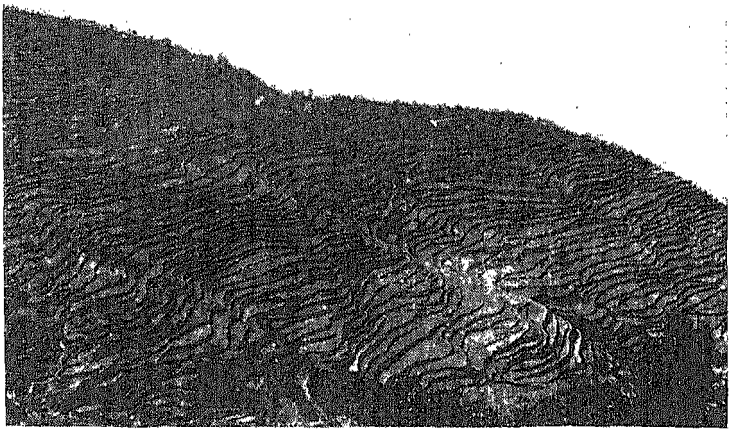
The use of drainage channels becomes necessary only where the slope is sharp as on hillsides, sub-montane areas, and alongside rivers. In the U.S.A. near Lubbock, Texas, may be seen examples of how rainwater running along a drain by the side of a public road is taken into a farm and utilized by the ingenious system of 'bench terracing'. In this method the water is taken to each field and is spread evenly over it, without being allowed to accumulate in any one place. In one case, the bed of a former shallow lake previously formed by the unrestricted flow of rainwater, now remains dry for the best part of the year because the water is instead led over several terraces and is allowed to soak in. The method raises excellent crops since it leaves a large reserve of moisture in the soil, and it could be adopted with great advantage in hilly areas throughout India. The rainwater is conducted along drains zigzagging down a series of terraces from the highest to the lowest levels. So much water is absorbed in each field that by the time it reaches the lowest terrace the flow of water is often a mere trickle. In this way not only is erosion damage to terrace walls, fields and drains prevented, but the moisture is absorbed deep into the subsoil of all the fields. All this is achieved at little or no cost, and surely the system should have been introduced systematically throughout the hilly and riverain slopes of India long ago. In the Nilgiris and parts of the Himalayas where unrestricted felling of trees has caused untold damage through erosion, terracing of a rough and ready sort is already practised, but not the kind of terracing whereby the scientific control of rainwater is achieved. If this type of terracing were practised, the danger from floods would be greatly minimized because the volume



An aerial view of properly bunded fields. This is what *daulbandhi* should look like. Much sheet erosion is saved and rainwater is conserved in dry tracts.

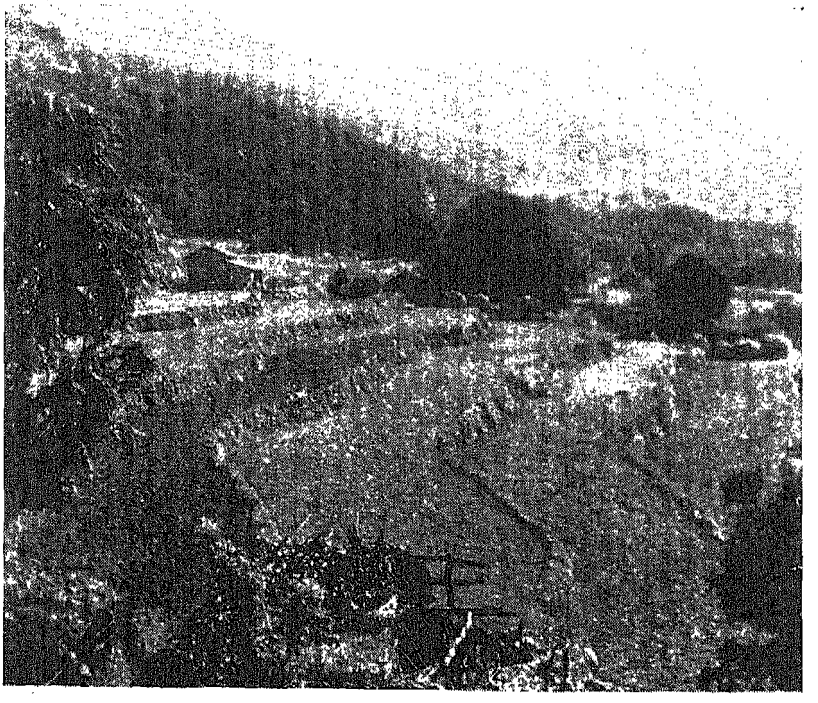
This *bund, bandh* or barrier to hold rainwater and stop erosion is larger than the ordinary *daul*. It has helped to secure the good *rabi* crop seen in the foreground.





Typical bench terracing in the hills. Channels to carry rainwater are absent and the fields mostly slope towards the valley. The slope should be towards the hillside.

Bench terracing on a gradually sloping Himalayan hillside. Channels to carry surplus rainwater from one terrace to another are not present as they should be.



of water reaching the rivers immediately after heavy rain would be reduced by means of its being led gradually over the surface of cultivated fields instead of rushing or cutting through them and down ravines.

Control of the flow of surplus water is an urgent necessity in India where floods do so much damage every year. The large-scale planting of trees on otherwise barren hillsides is one of the present accepted methods of attacking the problem, but it is a very long-term plan and is not enough by itself to save the country from floods. Controlled drainage over bench terraces, combined with tree planting in open spaces and on the borders of cultivated fields, is the obvious answer. The speed and efficiency with which such a plan is put into operation will make all the difference between a flood-stricken and a floodless India. Gully plugging or the checking of the flow of flood water in ravines and gullies is all to the good, but is not the complete answer to the flood problem. Neither is afforestation. The damage done to India's watersheds by the ruthless felling of trees in the past, is not repairable by afforestation alone, for floods will continue until the trees have established themselves, probably not for another seven to ten years.

The need to save the country from erosion and floods is immediate, and must take priority next only to the direct stimulation of food production. The implementation of the bench terracing plan is therefore so urgent that the administration would do well to detail both paid and volunteer (Land Army) men and women to commence work with the least delay. Indian officials and others already in America under the Colombo Plan should be asked to visit Lubbock, Texas, and other places in the U.S.A. where bench terracing is to be seen, to acquaint themselves at first hand with this very simple yet effective method of utilizing rainwater and preventing erosion or flood.

Broad-based Terracing

The faulty cultivation of marginal land has resulted in very large areas becoming useless for crops because of heavy erosion; this frequently occurs on the uplands bordering on rivers and streams. A very common practice is for ploughmen to plough their fields up and down the slope instead of

across it. This results in furrows which offer no resistance whatever to rainwater rushing down, and the consequent erosion is very rapid in its effect. The simple expedient of furrowing against the slope does not for some reason occur to the vast majority of cultivators. Contour ploughing, as it is sometimes called, should be demonstrated as widely as possible.

Terracing on sloping land can either be of the bench type, as already described, or broad based, whereby resistance to the downward flow of soil-laden water is offered by banking up soil in strips 15 feet or more in width and about 2 feet high. The type of terracing to be adopted will largely depend on the slope of the land. For slopes of 50-100 feet per mile, the broad-based terrace is preferable. A special feature of this is the broad but shallow channel which alternates with the wide ridges. In regions of high rainfall these channels are given a slight gradient in order to get rid of the excess water, but in dry districts they are flat, allowing the absorption of the water that collects in them. Both the channels and the ridges are wide enough to permit cultivation so that crops are grown on them without wastage of any field space. Broad-based terraces get silted up in time by soil moving from the upper to the lower level of each field. The ultimate effect is to convert the area into gently sloping terraces of fairly flat fields in which erosion has been eliminated.

Erosion always begins at the highest level of a slope. Such remedial measures as gully plugging, bench terracing and broad-based terracing should therefore begin at the top, working downwards until the entire slope has been treated in the desired manner.

Strip Cropping

Another expedient for land which slopes rather more than the limit up to which *daulbandhi* or the raising of low earth barriers is effective, is known as strip cropping. In the first place, the ploughing must be done against, across or in opposition to the slope or contour. In the second, crops are grown in strips on these slopes, at least one of the strips being put under a thick spreading crop like gram, cowpea or groundnut. In Western countries clover makes an ideal strip cover crop. The object is to hold the soil and to

prevent it being washed down from the strip of some other crop higher up. There may be four, five or six strips depending on the area and slope of the field. This method of fighting erosion has the added advantage of protecting the inside strips from the depredations of wild animals, where crops like groundnut are grown.

Wind Erosion

The encroachment of desert sand, blown by the wind onto cultivated land to the leeward, requires very special measures. The raising of shelter belts of certain quick-growing trees is a measure adopted by the State of Uttar Pradesh in the Agra and Mathura districts where the desert is encroaching on fertile land at an alarming rate. Proper land use, however, is more likely to be the answer to this serious problem of wind erosion than the planting of shelter belts. Such grasses as the deep-rooted *kans* (normally a pernicious weed), that will hold the soil and resist erosion, are likely to prove of inestimable value, not only in holding up the march of the desert, but in reclaiming sandy deserts for ultimate afforestation. The same applies to *baisurai*, a deep-rooted and troublesome weed which flourishes during the winter season in Western Uttar Pradesh but resists drought during the season of hot winds (from April to June). This and another weed called *bui* (*Kochia Indica*) may well prove to be an invaluable means of preventing desert encroachment and curing established desert and semi-desert conditions. The wild and thorny shrub called *jharberi* is another possible ally of those who seek a cure for these conditions. One very great advantage of using weeds like *kans* and *baisurai* is that goats and other animals do not touch them for food. The main object of holding the soil against wind erosion, once gained, creates a condition under which further reclamation by afforestation becomes a definite possibility.

Controlled Grazing

One aspect of proper land use which is of the utmost national importance is controlled grazing. Grasses are as important in the prevention of erosion on sloping land as any other vegetative cover; in fact more so. Grasses form

a thick matting which can effectively check erosion. Not only the planting of *dub* (*Cynodon Dactylon*) and other good grazing grasses, but also their preservation through controlled grazing is therefore most important. In a country where the number of cattle to be grazed far exceeds that which its existing grazing areas can support, it is easier to recommend controlled grazing than to enforce it. The solution of the problem will occur to the reader in the chapter on land reclamation. There are vast areas all over the country which are crying out for reclamation by one or other of the simple and inexpensive methods recommended therein. If to the reclaimed flat lands, suitable for controlled grazing, are added the millions of acres of riverain land which are capable of providing grazing with or without afforestation, there should be enough grazing to enable the introduction of controlled grazing as a measure of the highest importance to the nation's rural economy. If a reduction in the growing population of useless or surplus cattle is effected as is suggested in chapter four, there is no reason why the ultimate incidence of cattle per acre of good grazing land in India should not be reduced to the scientific optimum, provided that land reclamation is seriously undertaken (chapter six).

Primitive methods of farming will take time to change. The effect of many years of demonstration by agricultural field workers must however eventually bear fruit. Improved implements of tillage are at present in short supply, and their manufacture must be speeded up. Servicing facilities, spare parts and the implements themselves must be made available to the farmer, at prices which he can afford. Supplies of fertilizer, town compost, bone- and fish-meal and the like should be available more easily and at a lower cost than at present. The conservation of all organic matter, animal and vegetable, must be insisted on; legal, co-operative and individual organization not only for the prevention of further fragmentation, but rather for the consolidation of holdings, must be set in motion by the State; cheap agricultural credit must be made available through co-operative societies; the control of weeds, diseases and pests must be exercised seriously. If all this is done, there need be no further loss of agricultural production due to primitive

farming methods. But the State cannot do it all alone: voluntary help from retired officials, university students and the public generally will be badly needed.

Another glaring example of the present waste of soil wealth is the loss to India's cultivable area of millions of tons each year of human and cattle excreta, weeds, crop residues, wood ashes, street sweepings, tank and pond silt, and the carcases, including bones of dead animals.

Bulk Manure

Many years ago at the Wardha Ashram in Madhya Pradesh (old Central Provinces), a simple method of saving human excreta for our soils was demonstrated. More recently a movable latrine on wooden wheels has been used to good effect. This consists of a wooden frame on four wheels to which cheap gunny screens have been nailed. Inside is a seat. The latrine is used over a previously dug trench about 10 inches in depth. After use, some of the earth on the sides is pushed into the trench. The excreta is thus preserved and utilized by means of this simple and cheap contraption as plant food. In order to persuade villagers to use these movable latrines, the State, on the recommendation of the panchayats, will have to offer rewards at first to those using them most consistently. If this fails, a system of fines could be imposed on those who do not use the trench as directed. The 82 per cent of the country's population which lives in villages must be made to conserve this important ingredient of soil wealth for the fields adjoining the villages. Later, and by gradual stages, the use of night soil and other forms of organic matter as manure can be included in the curriculum of rural schools throughout the country. Only when everyone realizes the full value of organic matter and especially of human excreta as plant food, will it be possible for the country to produce crop yields comparable with those of other countries.

Between 1948 and 1950 a number of Acts were passed in some Indian States making the preparation of compost from sewage and rubbish by municipalities compulsory. The Bihar Municipal Bill, 1949, makes it obligatory for all municipalities to prepare compost manure from sewage and rubbish, if so required by the State government. The C.P.

& Berar Municipalities (Third Amendment) Act, 1948, amends Section 50 of the 1922 Act to provide for the preparation of compost manure from night soil and rubbish. The Madras District Municipalities (Orissa Amendment) Bill of 1949, and the Bihar & Orissa Municipal (Orissa Amendment) Act of 1949, make similar provisions for the State of Orissa. The Bihar Act goes further and makes compulsory the removal of sewage, rubbish and offensive matter from all public places within the notified area and its collection for the preparation of compost manure. The East Punjab Conservation of Manure Act, 1949, is perhaps the most far-sighted enactment of its kind. Its main provisions empower the State government (a) to declare any area within the limits of any one *tahsil* to be a notified area for the purpose of conservation of manure, and (b) to make the occupier or head of a family in the notified area liable to conserve manure. The Punjab Municipal (East Punjab Third Amendment) Act of 1949 provides for the compulsory preparation of compost manure from cow-dung by any municipal committee, if so desired by the State Government. This enactment does not go far enough in that no mention is made of sewage, and will doubtless be amended in due course. The Hyderabad State Refuse Ordinance makes it compulsory for municipalities to convert town refuse into manure. The Madhya Bharat Village Refuse Ordinance of 1950 provides for the conversion of village refuse into manure. Finally, the same State enacted a Municipal Refuse (Conversion into Manure) Act in 1950, providing for the conversion of refuse into manure within the limits of any municipality.

All these legislative enactments are more or less useless unless each state takes the initiative in getting municipalities not only to manufacture the compost but also to arrange for its distribution. Municipalities are as a rule poor, and adequate funds will be needed to produce the desired results. In this, again, each state will have to devise ways of raising funds and to see that they are used wisely. The larger towns in Bombay, West Bengal, Uttar Pradesh, Rajasthan and other states have enormous potential agricultural wealth in sewage which is at present wasted. Legislation to conserve and distribute this wealth is needed most urgently.

A method of treating sewage to produce an odourless sludge which is most useful as a fertilizer on the one hand, and a clean, clear liquid containing quantities of plant food on the other, has been adopted with success in the West. In India, the larger towns could provide the surrounding farmlands with the millions of tons of valuable plant food which are at present led into rivers or the sea and so completely wasted. The cost of utilizing town sewage by this method has been used as an argument against its general adoption in India. Perhaps a concrete example will help to show that it is not really expensive. In Lubbock, Texas—where bench terracing is practiced—3 million gallons per day of sewage was being treated in 1946 in an activation plant outside the town. As the sewage comes into the plant, it is deodorized with ferrous chloride, for which the normal and ample supply of water with which town sewage is flushed can be substituted more cheaply. In the case of the Lubbock Scheme, the entire plant cost the City government 234,000 dollars and employs only six men, the electricity used being about 1,200 kilowatts per day. The gases which emerge in the process of aerating the sewage can be used to generate electricity, thus reducing the working costs. The clear liquid from the aerating tanks is sold to a farmer who uses it to irrigate a 700-acre farm to which it is pumped. The land on this farm which was poor before, has by using this effluent been greatly enriched, and yields the farmer a net profit of 20,000 dollars a year. He pays only 1,800 dollars a year for the use of the effluent from this plant. The dry solid precipitate which collects at the plant is eagerly bought by other farmers, some of whose farms are quite a distance from the dump.

The Indian Planning Commission anticipates that an expenditure of 112 crores of rupees will in five years yield 5·57 million tons of additional food. Nowhere in this plan is there any mention of utilizing town sewage in the manner described and yet, from this illustration, it is not difficult to see how greatly crop yields would benefit by such a scheme. Indeed it may yet be discovered that money spent on utilizing human excreta for agriculture pays much higher dividends in additional food produced than equivalent amounts spent on the 'Grow More Food' schemes under

the Five Year Plan. Now that high-grade foreign experts are available for advice under various international schemes, it should not be difficult to have this scheme examined in all its aspects. It might then be found that money diverted from the one scheme to the other would serve the country better in its urgent need of more food.

China and Japan have long since realized how very valuable sewage is. The method of activation adopted in those countries is simple and inexpensive; it consists of stirring the stuff in large open vessels. The action of air thus forced into the thick fluid causes it to lose its smell, and when it ripens it is ready for application in the fields. In India it would be costly to employ the caste of people who handle sewage and there would not be enough of them to activate even ten per cent of what at present goes to waste. Hence, therefore, either all Indians must overcome their prejudice against this type of work, or money must be found for activation plants to serve all cities, together with piping and transport facilities for the distribution of the finished product over the nearby grain-producing fields.

Not only has India a very large human population, but it has also the largest cattle population in the world. And what is happening to the nitrogen, phosphates, potash and minerals that pass out of the bodies of these 177½ million cattle? Most of the urine is lost from carelessness allowed through ignorance of its true value as potential plant food, and a large part of the solid excreta disappears as fuel. Even the ash residue from dung cakes is mostly lost by careless handling. Agricultural research in India has resulted in many useful practices including those whereby cattle urine can be preserved as manure, and one by which dung can be turned into valuable compost with the help of weeds and crop waste. The trouble is however that these useful practices are confined mostly to government farms and similar institutions. The preservation of cattle urine should be the national duty of every cattle owner and should be enforced, if necessary by means of legislation.

While cattle are grazing, it is impossible to collect their droppings on a large scale, but where they are tethered for the night, it is not only possible but costs very little in cash and in labour. Loose earth or a bedding of leaves or crop

waste should be spread under the cattle. The solids are then removed, some for burning as dung cake and some to the manure pit, and the urine, absorbed by the loose earth or crop waste, in time becomes the most valuable ingredient of the manure pit. It is not necessary to replace the loose earth or other absorbent material more often than once in two weeks or so.

If this procedure was regularly practiced, the supplies of organic manure to the country could easily be increased by fifty to sixty per cent or more; and the effect on crop production of so great an increase in manurial application can be calculated from experimental results available of the differences between yields from plots treated and those not treated with urine earth. This varies; but for a crop like wheat it can be as high as fifty per cent.

COMPOST

Another aspect of this question of saving organic matter for fields producing food, is the proper utilization of (a) weeds, (b) street sweepings including crop waste, (c) tank silt and (d) ashes, all of which are valuable sources of fertility. Ashes are not strictly organic matter but they play so important a part in the process of making compost that they are included in this list. It has been estimated that from one half to two thirds of the total available supply of cattle dung is burnt in the shape of dung cakes by the village housewife. This is due less to inadequate supplies of firewood than to the fact that cow-dung makes an excellent slow fire for boiling milk and for cooking food generally. It would therefore be wrong to deprive people of this fuel without providing a suitable substitute and, until such a substitute has been found, dung must continue to be used. Fortunately, it has been found that about a quarter of the solid excreta of cattle available would be enough to meet immediate requirements. This does not imply that it would not be desirable to return to the earth as manure the entire excretions of both cattle and human beings; but even if a quarter of the solid element were carefully preserved, and with it green weeds and all such easily decomposable crop waste as stubble, straw of oilseed crops, leaves and the like, a mixture of these ingredients with ashes from village

hearths and urine earth would make a compost as rich in value as cattle dung itself.

The value of compost is now known to all agricultural departments of the various state governments and it is now only a question of demonstrating the making of compost to the villages. The first essential is to make the collection of all weeds in the green stage before seed formation, all ashes, all crop residue readily subject to decomposition in the manure pit, compulsory for all agricultural workers, and, if necessary, fines should be imposed through village panchayats for failure to conserve these valuable ingredients of compost.

Other Fertilizers

There remains the consideration of how best to utilize village tank silt and the bones, flesh and blood of dead animals. One of the characteristic features of Indian villages is the presence of a water tank which fills during the rains and serves various purposes. If it is large enough—which is seldom the case—it is used for irrigation, but generally it is used to water cattle or to wash clothes in. Being in a depression, the tank collects surface dirt from higher ground, and the result is that it silts up and has to be cleaned from time to time. Occasionally the value of tank silt as manure is appreciated by the village folk, but not often enough, and one of the first things a Land Army should engage itself in is the deepening of village tanks and the removal of the silt to the fields adjoining. If this was done once a year in April or May, the tanks would supply a considerable amount of manurial matter and the remaining water would be cleaner for the purposes for which it is at present used.

Turning to bones and carcases, there is at present a colossal wastage of phosphates and nitrogen because of the practice of leaving dead animals to be devoured by vultures. Here again is work for a Land Army which could train villagers in burying carcases so that the pits could be opened in due course and their contents used as manure. The location of the pits and the allocation of the manurial content should be a matter for village panchayats to decide. There are of course many carcases on the larger grazing areas which cannot be pitted because of their distance from the

village or cultivated land. In these cases, there should be an organized collection of bones for subsequent sale to mills where bonemeal and other by-products can be made. Finally there are the slaughter houses where, since the slaughter of cows and their progeny has practically ceased, buffaloes, goats and sheep only are slaughtered. Much valuable blood and offal is wasted at these places and it is high time that these were converted into dried blood and other material of value as fertilizers.

The Sindri fertilizer factory in Bihar is the largest of its kind in Asia. It will eventually provide India with about a third of the country's requirement of sulphate of ammonia. This fertilizer does more harm than good to fields other than those which have a satisfactory humus content or, in other words, contain the organic matter that is at present being wasted. Organic matter helps among other things to make dry soil retentive of moisture. It also helps to bind particles of loose soil together and, in the case of clay, assists flocculation, which in itself is an aid to the soil. The use of fertilizers without the addition of bulky manures like compost can be harmful in the case of clayey soils and wasteful in the case of such light soils as sandy loams. In a country like India where there is little moisture during seven or eight months of the year, the saving of all organic waste matter is as important to food production as is the saving of electrical energy in a modern industrial town where the demand exceeds the supply.

Ashes from brick kilns have been found by experience to make valuable manure for fruit orchards. Similarly, the reddish earth near the foundation of very old buildings is an excellent fertilizer for certain crops like tobacco, and saltpetre, which often occurs naturally as an incrustation, has a fertilizer value. The country cannot afford to waste any of these materials, for on its increased agricultural production will depend much of its future economic strength. India could be exporting enough agricultural raw products to buy all the imported goods it needs; but much depends on how the many problems discussed in this chapter are handled.

CHAPTER FOUR

SURPLUS CATTLE AND OTHER CROP PESTS

THE cow is venerated in India for a very good reason. 'Gao mata' or 'mother cow' as she is called, provides or should provide the poorest of people, the sick, the infirm, and our growing children with one of the essentials of life, milk. Over 80 per cent of India's peoples depend on the male progeny of the cow for bullock-power, so essential for the nation's existence. As far away as Florida in the U.S.A., Indian cattle are kept for breeding purposes and, in this age of artificial insemination, the seed of some breeds of Indian bull is in demand in other distant lands also. Not only in beauty of form, but in their economical feeding habits and their resistance to disease, our best herds are unsurpassed. No breed of milch cattle in the whole world, with the exception of the Jerseys and Guernseys of the Channel Islands, can compare with our cows in the high percentage of butterfat in the milk they produce. The milch buffalo produces nearly a pound of butterfat with every ten pounds of milk that is drawn from it.

A century ago, when the cattle population of India was much smaller than it is today, and cattle were properly fed because grazing grasses were not in short supply, and concentrates like gram were cheap, the problem of over-population did not arise. Today the situation has completely changed. Well managed and properly fed, pure or nearly pure bred herds, are the exception rather than the rule. Large herds of ematiated and completely useless cattle stray about trying to eke out an existence on wholly inadequate grazing. Cattle that have become wild and roam in some of our jungles are better off than these unfortunate half-starved and ill-shaped remnants of our once flourishing herds. Some of our goats produce more milk than these poor cattle.

All this has happened over a period of a hundred or a hundred and fifty years. Why? The gradual rise in the

human population during the period of comparative peace from the early nineteenth century onwards, resulted in a demand for cultivated land at the expense of grazing areas. Cow slaughter unfortunately became indiscriminate, with the result that many really good cows found their way to the slaughter house during the period between lactations. This was particularly noticeable in the neighbourhood of large towns where the maintenance of dry cows for three or four months was a costly business, and where the owner consequently followed the line of least resistance. The good cow was sold for a fair price to the butcher and, with the proceeds of the sale, another good cow in milk was bought in some outlying village. This new purchase was fed and kept in good condition so long as it was in milk, but as soon as it went dry, it was disposed of, and the process was repeated again and again. During the two world wars, when there was a large demand for beef for the armies in India, high prices were paid for well fed cows and their progeny, and this had the inevitable result that good milkers became scarce.

The stoppage in recent years of this wasteful practice, harmful in the extreme to India's rural economy, has been a boon to the country, and those who agitated for reform are to be congratulated on their achievement. But we are still left with the problem of a surplus population of scores of millions of useless cattle which are a drain on the country's available fodder and grain supplies. It is no easy matter to deal with this problem. One can only discuss possible solutions and hope ultimately to find the right one. The situation has become so serious that it is impossible in some parts of the country to protect growing crops from grazing by wandering cattle. Years ago it was one or two stray animals which could either be driven off or sent to the nearest cattle pound. Today it is a question of constantly being harassed day and night by herds which must either feed on one's green crops, or starve: How long can this state of affairs be allowed to continue? Fencing is too costly for the average farmer and so are watchmen.

SEGREGATION AND STERILIZATION

One solution, that should be workable, lies in the segregation of these cattle, local expert committees having

decided which of them are really useless. This means that a small compensation must be paid to the owners of these animals, and it should therefore be a gradual process, spread over a number of years. Meanwhile areas have to be selected and fenced if necessary, so that the herds are confined to them. Our sub-montane lands abound in rich lush grasses and a beginning could be made in selected parts of these vast areas. The proper utilization of the carcases of animals that die in these reserves should provide an incentive for industrial or commercial enterprise, the bones providing fertilizer, the hides tans, and the rest compost. Incidentally, commercialization of the carcases would help to pay the cost of compensation, if not of fencing.

Another solution worth considering is the use of modern veterinary science for the purpose of sterilizing useless cattle, male and female, so that no more decrepit and utterly useless cattle are born. This to some may appear a somewhat drastic step, but it should be remembered that artificial insemination makes it possible to manage with a very few good stud bulls where hundreds were needed before. Assisting in the work of sterilization is where an intelligent and well-trained group of students forming part of India's future Land Army could be of real service to the country. It will be difficult at first to convince the cattle-owner that this solution is not only in the national interest but in his own. It must however be realized that we can make no progress if we are not prepared to do all in our power to overcome ignorance and unnecessary prejudices in our rural areas. To begin with, the sterilization of only the very worst cows and heifers, and the castration only of the very worst bulls, should be undertaken; for it is possible to build up a herd and improve the quality of its cattle, by using the seed of a really good pedigree bull. 'The bull is half the herd' is an old saying and is pertinent to the present discussion, as there are far too many sub-standard bulls roaming the country and reducing the already poor quality of many herds. Sterilization by castration is already commonly practised; it needs only to be modernized and intensified in a country-wide campaign for better male and female cattle and buffaloes.

The reverence in which the cow is held has resulted in a large number of *gaoshalas* or asylums for aged, infirm and

decrepit cattle, springing up over the length and breadth of the country. These institutions are supported by well-wishers of the cow and some of them are well managed. The time has come, however, for them to be utilized as cattle-breeding centres and as centres for training in artificial insemination, modern sterilization and cattle management generally. The existing herds in these institutions should form the nuclei of the new segregation centres for useless cattle in sub-montane grasslands. Such a step has already been taken in at least one state of the Union and deserves the praise and support of the public. In deciding which of the useless cattle should constitute the first and subsequent consignments sent into segregated retirement from any *pargana* or *tahsil*, the committee of experts dealing with the matter should co-opt the help of prominent and public-spirited men from the area. Similarly, in the management of the herds already segregated in the manner suggested, it would be well for the official experts to associate with non-officials who have had experience of cattle management, and of whom there is no shortage.

MONKEYS

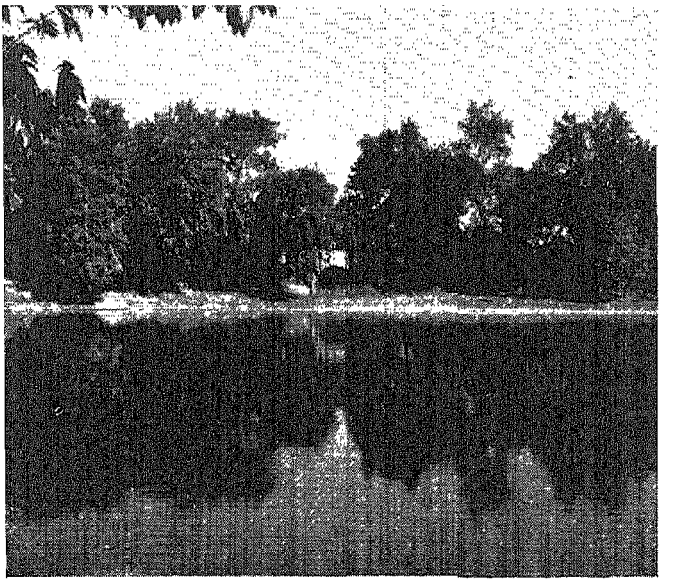
Next to surplus cattle, perhaps the greatest pest of food crops is the monkey. Replying to a question in the Council of States in New Delhi, the Minister for Agriculture said that, during 1952, 15,753 monkeys were exported from India. In the year previous to that 47,185 were sent. The United States, which has a large number of research institutes, is our chief customer. The monkeys are used mainly for research in diseases, and the utmost care is taken to see that they are treated as humanely as possible. Replying to another question, the Minister said that monkeys were responsible for damage to 5 to 7 per cent of our food crops and that they were exported mainly to get rid of them. Five per cent damage to our food crops represents a loss of about $2\frac{1}{2}$ million tons of food for human consumption every year. It would therefore be worthwhile trying to export larger numbers of these animals even if they have to be given away free to any foreign country that cares to pay the transport costs. It is doubtful, however, if the export of even 50,000 monkeys each year would make any appreciable

difference to their numbers, already huge and multiplying fairly rapidly.

Monkeys could go on living quite happily in our forests once they ceased to menace our field crops, and the question should be carefully examined by a team of experts. It may be possible to confine the entire monkey population of India within the limits of certain selected forests by means of electrified fencing. The voltage need not be strong enough to injure the animals, but sufficiently strong to give a shock which would effectively keep them away from the fence and within the forest. The answer to the problem of driving the monkeys into the forest in the first place can be found either in the methods already adopted to capture and export thousands of them or by an ingenious method once tried in a *tahsil* of the Jubbulpore district of Madhya Pradesh. It was early in the century that the depredations of the large long-tailed grey monkey, called the *langoor*, became a real menace to the countryside. The District Officer asked the *tahsildar*, a resourceful officer, to get rid of the menace, and this he did. Being a sportsman, he had a number of panther skins. He captured one of the monkeys and got a cobbler to dress it up in the panther skin and then let it loose. Its natural instinct sent it bounding after the herd from which it was taken. But it looked so much like a live panther that the more it tried to get in among its friends, the further away did they flee from it. The chase appears to have ended somewhere in the Himalayas, for the herd was never seen again. That is a true story and it may well provide the answer to a vexed problem in which religious and humane feelings preclude the large-scale destruction of this pest. How far sterilization of a proportion of both sexes is either desirable or feasible, is for experts and administrators to decide.

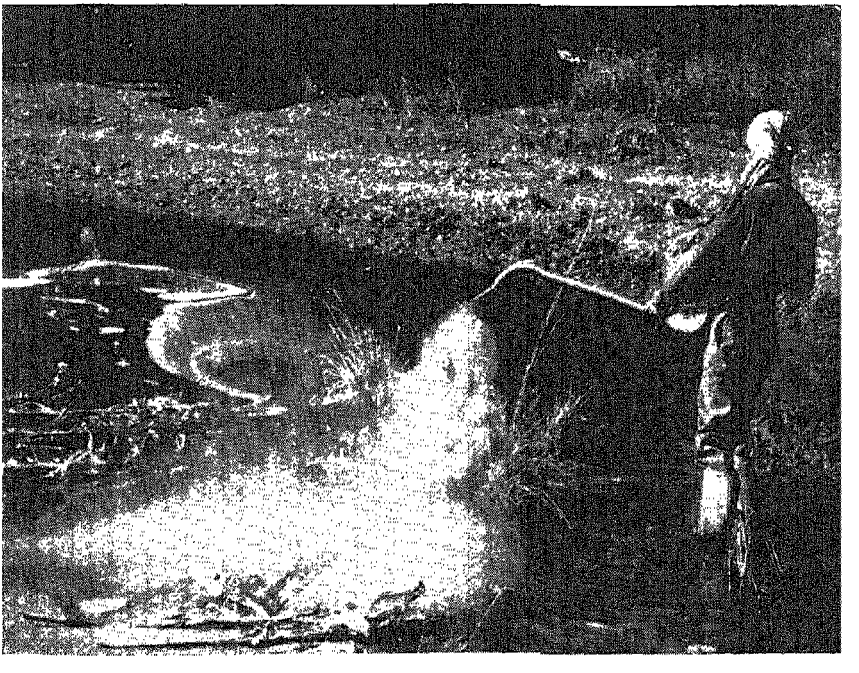
Nilgae or Blue Cow

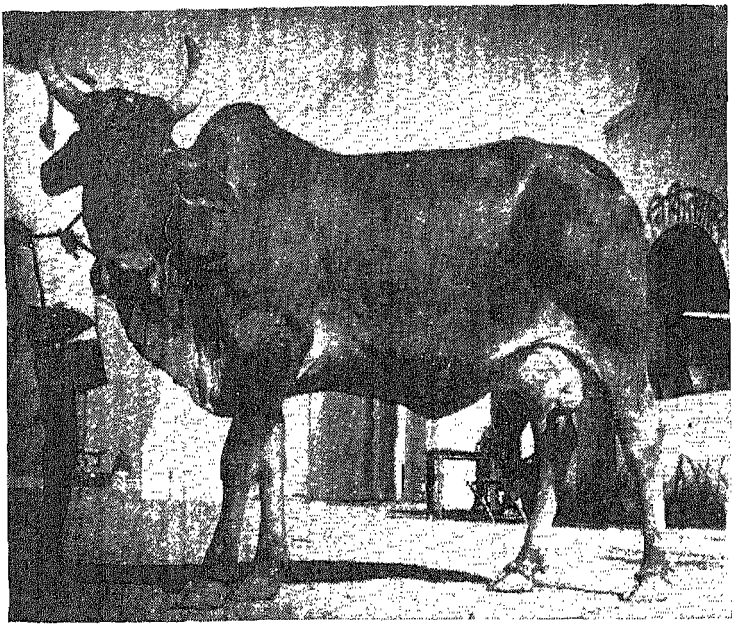
Next in importance among animal pests is possibly the *nilgae*, a name which means blue cow, although the animal has little or no resemblance to a cow. It is a deer, and along with other deer causes very considerable losses each year to growing food crops. Because of its name and for no other reason, there exists a curious prejudice in some parts of India against its destruction. Recently, however, this



Bunding and afforestation to check erosion in the Ganga ravines near Kanpur. *What was once bare eroded land is now a valuable forest mostly* of *sheesham.* Water is often held up in depressions as a result of such treatment.

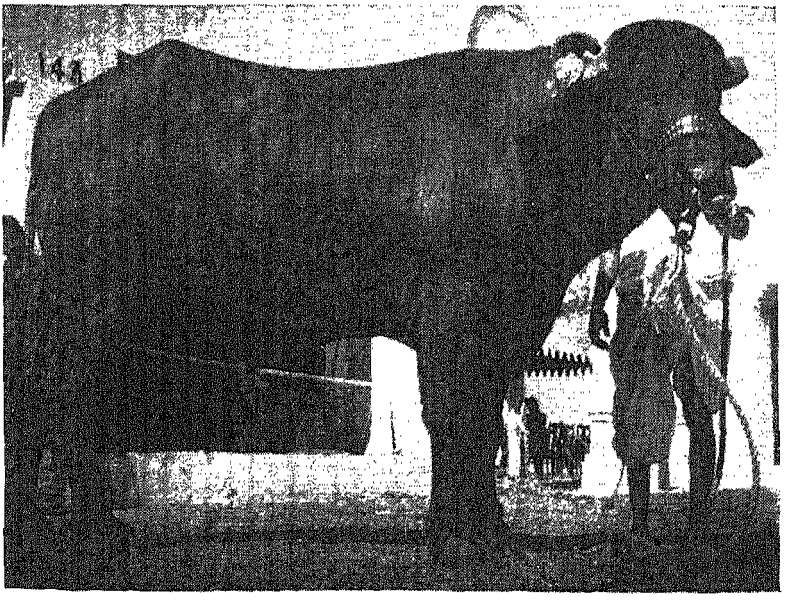
Fighting malaria to make rich sub-moutane land inhabitable.





A prize-winner. The Sahiwal cow is unsurpassed in India as a heavy milker. Its home is in Central Punjab where milch cattle are unusually well fed.

A prize bull of the Murrah breed of buffalo which has its home in South-east Punjab. The female buffalo is India's richest source of butter-fat.



prejudice appears to be disappearing and in any case seems to be in inverse ratio to the amount of damage done by the pest in any particular area. The full grown animal looks more like a horse than a cow and weighs about 800 pounds. It consumes a great deal of food and many a farmer complains bitterly of its depredations. In the State of Uttar Pradesh, the name of this animal has been changed to *nilghora*, meaning blue horse, the idea being to get people to recognize it for its destructive propensities, and to obviate the sentiment adhering to the name blue cow.

Although the Uttar Pradesh Government appreciates the extensive damage done by this pest, beyond changing its official name no organized effort to reduce its numbers has so far been made. Ammunition is expensive and, with the abolition of the feudal system, the number of shikaris has diminished. The result is that the number of *nilgae* that roam about feeding on growing crops is on the increase. The same does not apply equally to other animals of the deer family for the simple reason that black buck, *cheetal*, *sambhar*, *gond* and smaller deer are more sought after by sportsmen. With the exception of the black buck and the *nilgae*, most of these deer live in the larger forests and damage crops only in the near vicinity of afforested areas. Reduction in the number of black buck can best be brought about by encouraging sportsmen with rewards. *Nilgae*, on the other hand, being much larger and tougher customers, are not easily killed other than by the most enterprising sportsman armed with suitable ammunition. If, however, the wild elephant can be captured and trained as a beast of burden, why not the *nilgae*? The method of driving these animals into kraals or stout palisades ought to be successful, and in this way there need be no killing of these beautiful beasts and they might be trained for the many useful purposes for which bullocks, ponies, mules and donkeys are used. It is an experiment worth trying and the sooner it is undertaken the better. Once trained, their numbers can be kept down by the prevention of unrestricted breeding.

Wild Boar

The wild boar too is extremely destructive to farm crops and its numbers also are on the increase. This pest presents

a somewhat different problem, in the matter of destruction, to that of surplus deer. The pig does not often stand and present a stationary target to the marksman: he usually has to be driven out of thick brush or long grass and he then presents a rapidly moving target. Shooting him with a rifle is to endanger the beaters. Shot guns could of course be used, but the results obtained are not likely to be commensurate with the trouble and expense involved in a substantial reduction. The most effective way of destroying wild pig is probably to drive them into deep trenches prepared beforehand. These trenches have to be deep enough and steep enough to prevent the animals climbing out again once they have fallen in. Also, it has to be covered lightly so as not to be recognized as a trap. In dimensions, a depth of 6 to 7 feet, a width of 4 feet at ground level and 5 feet at the bottom should suffice. Once secured in the trench the animals could be speared and their hide used by certain castes of villager. The bones and offal would make valuable fertilizer and the bristle is always prized by the brushware industry.

Porcupine

Porcupines destroy crops only at night, and their destruction can best be effected by employing professional hunters, offering them suitable rewards. The flesh of the porcupine is prized by certain castes, and the rest of the carcase would be useful for the manure pit. It is also possible that some use could be found for the quills of the porcupine in cottage industries.

Wild Elephant

Wild elephants cause considerable damage to paddy and sugarcane in the neighbourhood of their jungle haunts, and to their number are now added the surplus elephants no longer required by feudatory chiefs and the abolished zamindaris. As far north as the district of Naini Tal in Uttar Pradesh, wild elephants have in recent years consumed hundred of tons of rice and sugarcane, and the ravages of this largest of all animal pests are well known in Assam, Mysore and other parts of India. The number of Indian elephants that can be sent as gifts to friendly countries is

limited; so also is the number that can be absorbed by zoos and circuses. It therefore becomes necessary to find some other way of reducing their number. To destroy wild elephants is not as easy as would appear at first sight: they are just as anxious to keep away from human beings as are any other wild animals, and at times they can be even more vicious and dangerous. There are, according to books on hunting, three vital spots for a good marksman armed with a heavy sporting rifle to aim at : the temple, the point of junction of trunk and head, and the heart. The first two are comparatively small targets, particularly as it is not usually safe to get any nearer than one hundred yards to a wild elephant, as the writer can testify from bitter experience. The heart shot is not as safe as the other two because it may not kill instantaneously; and within a few seconds a lot can happen to the marksman. After the ivory of a dead tusker has been removed the bones and the rest of the carcase are valuable material for fertilizer.

BIRDS

Crows, parrots and sparrows are very destructive to food crops, especially to maize, millet, wheat and rice. But before any large-scale destruction of these pests is undertaken it would be desirable to obtain the advice of an expert committee, as a number of birds that cause damage to crops also help to keep down harmful insects. So far as methods of destruction are concerned, the easiest way is to smash the eggs in the nests; but, please, only after carefully studying the habits of each pest.

An extraordinary case of extensive damage to crops was reported recently from Assam. On 31 December 1952, the following paragraph was published in a well known Indian newspaper: 'SONG BIRDS DESTROY ASSAM CROPS. Indian nightingales are reported to be causing enormous depredations in several villages of the North Salmara police circle of Goalpura district. It is stated that these birds, famous for their melodious notes and thought to be innocent and harmless, swoop in their thousands on potato and paddy fields and eat and destroy them in large quantities. The harassed villagers have sought government help. They told the Food and Rural Development Minister, during his recent

walking tour of the district, that unless some action was taken against these menacing birds, they might be compelled to leave for safer zones.'

Well might the farmers of other states of the Indian Union make similar representations against the depredations of parrots and other bird pests. The villagers' only weapon against these pests is the laborious process of keeping watch and making noises; but experience has shown that in spite of these methods extensive damage is done each year to our food crops.

For the destruction of any pest other than wild animals, once the expert has devised the most effective means of destroying it, the co-operation not only of the villagers, but of volunteers from India's future Land Army will be necessary. Training, equipment and leadership will be needed. Organized destruction under the control of an entomologist will go a long way towards preventing wastage of food-grains running into millions, if not tens of millions, of tons each year. For if the damage done annually by birds, rats, white and black ants, and other insects was calculated, the result would be truly astonishing. At a time when the country should be straining every nerve to adequately feed its growing population, this is a matter of the greatest importance to its rural economy. While the Five-Year Plan is in operation there is no reason why some of the country's resources, especially its manpower, should not be employed in fighting the pests that are depriving millions of its inhabitants of their daily bread. It brooks no delay.

CHAPTER FIVE

THE CONSOLIDATION OF HOLDINGS

ECONOMISTS calculate that the income from farming compact holdings is 20 per cent higher than that from equivalent scattered or fragmented ones. (In Switzerland, as a result of consolidation, gross returns per acre have increased from 16 to 20 per cent.) Expenditure on cultivation or tillage increases by 5·3 per cent for every 500 metres of distance that men and bullocks have to travel; by 20 to 35 per cent on transport of manure, and 15 to 25 per cent on transport of crops.

It is not possible to make any accurate calculation of the additional production of foodgrains which an increased income, due to consolidation, represents. But take a family of 4 persons whose holding has been consolidated: Let us assume that before consolidation the holding was divided into 4 fragments, each 0·8 of an acre in area and separated each from the other by an average distance of 150 yards. These assumptions will be found to be reasonably within the average conditions prevailing in a state like Uttar Pradesh. Now suppose that the family of 4 had, before consolidation, a net income of Rs 20 per month exclusive of the value of the grain they produced and ate. This means that the total value of produce sold by the family, apart from what they ate or otherwise consumed from the produce of their fields, was excluding production expenses roughly worth Rs 240 per annum. Assuming that half of this (a fair assumption in non-irrigated areas) represents receipts from foodgrains (Rs 120), at an average price of Rs 15 per maund, this would represent 8 maunds of surplus grain sold. With the same fields consolidated, and assuming an increase of net income by 25 per cent, there is now 10 maunds of foodgrains available for sale each year. Translating this increase to overall figures; if all the 224 million acres under food crops in India today were consolidated, the additional production would be as much as 5 million tons.

One of the reasons why Indian growers are not producing satisfactory yields of food crops is that much of their limited bullock- and man-power is wasted in moving up and down between the scattered strips of land which make up their holdings. They have little time left to conserve manure and carry it to their fields; to dig wells and water their crops; to put up barriers to save their soil from erosion, or even to cultivate their fields properly and in time. Experience in France, Switzerland, Denmark, Ireland and other countries has shown that consolidation and the prevention of fragmentation thereafter, has made all the difference between want and prosperity. In Denmark, to take but one example, 'The present law governing division of land and inheritance has been instrumental in preserving the integrity of existing holdings and in preventing fragmentation. The reasonably effective consolidation of agricultural land into sizeable holdings, may be said to be an essential cause of the high state of development of Danish agriculture, the high standard of living of the Danish farmer, and the prosperity of the country as a whole.' This is the opinion[1] of the World Food and Agriculture Organization.

The cost of consolidation of holdings in India can, according to one authority,[2] be met by a once-and-for-all levy of four annas per acre. Although this is certainly not too great a sacrifice to expect of India's cultivators in the interests not only of the country's emergent need, but very definitely their own, cost is not the main consideration. Consolidation and the prevention of future subdivision are vital to India's economy as further shrinkage in the size of holdings would strike at the very root of the country's economic structure. Dr H. Mann's survey[3] of a typical village in Bombay State showed that the average holding had shrunk from 40 acres in 1871 to 7 acres by 1914-15. In Hyderabad, the average holding decreased from 23 acres in 1880 to 14 acres in 1945. The same trend was apparent in Uttar Pradesh.

[1] *The Consolidation of Fragmented Agricultural Holdings* (F.A.O., September 1950), pp. 53-4.

[2] B. M. Singh of the Board of Agriculture, U.P., in an article entitled 'How to make India Self-sufficient in Food Production' (*The U.P. Co-operative Journal*, Vol. XXVII, No. 1, July 1951).

[3] See *Agricultural Legislation in India* (Government of India, 1950), Vol. II, p. i.

Fragmentation due to the co-sharers' insistence on getting plots in each type of soil in the holding, has led to land going out of cultivation, because of some plots becoming too small for profitable cultivation. Some idea of the extent to which fragmentation has ruined profitable farming can be gathered from the village surveys that have been carried out in recent years. In one Punjab village it was found[1] that the land was divided into 1,898 fields averaging one fifth of an acre, and another 2,890 holdings had each over 3 fields. In another village 12,800 acres were divided into 63,100 fields. In Bihar, the average size of plot was found to be between 0·28 and 0·81 acres. But perhaps the worst case was reported from the Chattisgarh division of Madhya Pradesh where the average holding, generally 10 to 12 acres, was scattered over the village in no less than 30 to 40 small plots. In Ajmer the number of plots per holding varies from 3·3 to 3·5. An official publication summing up[2] this situation declares that the operating unit in agricultural production has become so small as to impede good cultivation. It is in fact considered the biggest single factor contributing to an unhappy state of affairs. Overhead costs have increased as a result and human, cattle and material resources can no longer be utilized economically. This authority further considers the existence of a very large number of holdings of the wrong size and shape to be an important reason why production and prices are so unstable.

It calls for immediate legislative and administrative action to put a stop to this deplorable state of affairs. Once further fragmentation has been stopped, consolidation can begin and, although it is a lengthy process, it could be expedited with the help of a Land Army of national volunteers.

The History of Consolidation

It would be well here to trace briefly the history of measures already taken to consolidate holdings. It was in 1947 that the Bombay Prevention of Fragmentation and Consolidation of Holdings Act No. 62, was passed. This was followed in 1948 by the East Punjab Holdings (Consolidation and Prevention of Fragmentation) Act No. 50. These

[1] *Agricultural Legislation in India*, Vol. II, p. ii.
[2] Ibid.

Acts went further than any of the legislative or administrative action of the previous fifty years, in that for the first time the State Government took the initiative in dealing with the evil of fragmented holdings. Even though these two Acts do not directly provide for the creation of economic holdings, they go far towards that end by fixing and determining for any area and class of land the size of a plot that can be profitably cultivated. This is called a standard area, and any portion of land less than the appropriate standard area is defined as a fragment, and the transfer or partition of any land which will create a fragment is illegal. Breach of this provision renders the transfer or partition void and the offender is liable to a fine of as much as 250 rupees.

The law also limits the powers of courts in that they cannot permit any partition which results in fragmentation. Even state governments and local bodies are prohibited from acquiring or disposing of land which leaves a fragment. The Bombay and Punjab Acts further empower the state government to notify any area in which it desires to prepare and enforce a scheme for consolidation of holdings, and in the Punjab Act of 1948, proceedings for consolidation can be instituted either on the Government's own initiative or on an application made by the owner of the land.

The fact that legislatures in most Indian states have favoured the principle of control and compulsion as visualized by the framers of the Bombay and Punjab Acts shows that there is hope yet of solving this very difficult and serious problem; for in the past too much was left to the initiative of co-operative societies and the villagers themselves. The situation was serious enough in the early part of this century and if compulsion rather than persuasion had been used then, India would today have been self-sufficient in food and would have been saved the many evils that have resulted from agricultural under-production. It now remains for state legislatures to enact legislation on the lines of those in operation in Bombay and the Punjab with the least possible delay, and to see that prevention of fragmentation accompanied by consolidation of holdings becomes an accomplished fact for every village in India.

The Uttar Pradesh Zamindari Abolition and Land Reforms Act of 1952 and the Assam Panchayat Act of 1948

lay on the panchayats the duty of encouraging consolidation of holdings on lands within their jurisdiction. But merely to lay this burden on the panchayats is not enough: Unless the state exercises compulsion, the failure to achieve any substantial measure of success in consolidating holdings and to prevent the fragmentation which has accompanied persuasive measures during the last fifty years, will be repeated.

THE EXPERIENCE OF OTHER COUNTRIES

The experience of other countries is an interesting study. In Switzerland, where some of the earliest laws concerning consolidation of holdings were promulgated, considerable stimulation was given to land improvement by the State. The law authorized the Confederation to grant financial assistance 'to facilitate the application of measures tending to stimulate agriculture'. Consolidation of holdings was one of these measures and, as a general rule, 60 to 70 per cent of the expenses were met by federal grants. In the mountainous regions the amount was sometimes as high as 90 per cent. But even so generous a contribution by the government failed to achieve the desired end. It was realized eventually that in the absence of power 'to compel the adherence of recalcitrant owners' there could be little or no progress; so the Swiss Civil Code in 1912 provided for compulsion to be used, and when two thirds of the interested persons decided to carry out consolidation, the other owners were compelled to adhere to this decision. The land improvement syndicates established on this basis are 'public bodies subject to the general supervision of the administrative authorities'.

In Denmark, the Consolidation Act of 1781 prescribes in detail all rules governing consolidation. Among its most important provisions is the right of every owner of land in a village to demand that his land be consolidated. The authorities, in consultation with the owners of land, prepare a proposal for the consolidation of the whole area of the village, irrespective of whether or not all owners wish to have their land consolidated. Another provision requires consolidation to be carried out in such a way that each owner gets the same economic area as he had previous to

consolidation, and the quality of land is for this purpose determined by disinterested parties. The owners are required by law to contribute to the aggregate consolidation expenses '*pro rata*, according to size of their land and the immediacy of their interest in the operations'. Each farm in the process of consolidation must be given the most practical shape possible. Finally, if no agreement can be reached between the owners of land, the dispute is settled by the authorities and in the last resort by the government. The present law governing inheritance in Denmark (and consequently division of land) has helped to preserve the integrality of existing holdings and to prevent fragmentation.

Legislation dealing with consolidation in France was promulgated only in 1918. Its provisions permitted proprietors, with the concurrence of a numerical majority of farmers, to consolidate holdings and effect any connected improvements to the land. This procedure does not seem to have worked smoothly in practice and many insurmountable difficulties occurred. The result was that consolidation proceeded very slowly. It was not until 1945, when an order brought into force an enactment of 1941, that results came more rapidly. The new law gave wide powers to a 'Communal Commission' which appointed a large number of surveyors especially designated for the work of consolidation. In 1948 there were more than 600 of these surveyors and their number was soon expected to reach 1,000, and with this number it was estimated that no less than 2½ million acres could be consolidated annually, the total area requiring consolidation being about 45 million acres. It appears that the 1941 enactment was a popular measure, for, without any special propaganda by the administration, the number of applications for consolidation by January 1948 had reached 2,700, affecting an area of some 5¼ million acres. The expenses of consolidation are met by the State, although 20 per cent is recovered from the owners after the completion of operations.

In Ireland the Land Act of 1923 provided that, with certain exceptions, all agricultural land in the Free State should, on appointed days to be declared, vest in the Land Commission. Wide powers were given to this Commission to enlarge holdings and effect other land improvement

measures and also to ease congestion by providing migrants from congested areas with land acquired elsewhere.

The Irish experiment, which appears to have been successful, is of especial interest to India. There are parts of East Uttar Pradesh and elsewhere where pressure on land is so great and holdings are so small that it is high time that congestion was alleviated. Voluntary migration of farming families is not likely to work, as people do not like to leave their villages, and language or dialect difficulties would arise if, for instance, a family migrated from the congested district of Gorakhpur to Hamirpur, 300 miles away, where the population is sparse. But if twenty square miles of culturable land were acquired in the Hamirpur district and a thousand families were brought from Gorakhpur and settled thereon, it would be a different matter altogether. The presence of the new population should act as a stimulus to the old. With the help of a few essential facilities including loans for sinking wells, building houses and the like, the experiment, if it should be successful, and there is no reason why under proper supervision it should not be, would be a great step forward in solving a problem which is becoming more difficult and vexatious every year.

In Ireland the Land Commission was given fairly wide powers to acquire both tenanted and untenanted land in uncongested areas for distribution to the incoming population. The procedure most suitable to Indian conditions is a matter for the various state administrations to determine, but the fact that such action has been of inestimable value in Ireland seems to suggest that it might solve the problem of congestion in India's overpopulated districts also.

So far as consolidation of holdings is concerned, there is ample evidence in India and other countries to prove that if it is left to private or even co-operative effort, progress is painfully slow. Opinions are divided on whether consolidation in India should be started on a voluntary basis through the co-operative societies. As there is no time left for further experimentation, let co-operative societies be formed of groups of villagers for the express purpose of consolidating holdings. This could be done by executive order of each state government. Simultaneously, legislation should lay down *inter alia* a time limit wherein the entire

cultivated area of each state is consolidated into compact holdings. This would not be unfair or too hurried, for the advantages of consolidation would be explained to the farmers before they joined the society. The powers granted to village panchayats under the existing law should be sufficient to provide the necessary check to any stray recalcitrant elements who refused to join. If necessary, these powers could be enhanced to include compulsion in such cases.

The Royal Commission on Agriculture in India, nearly a quarter of a century ago, said 'It is useless to think of real enduring Agriculture without Consolidation.' Yet the consolidation which has been accomplished during the last twenty-five years is infinitesimal. The time has come for state governments and legislatures to take effective steps to bring about speedy consolidation throughout India by some of the methods suggested here. In this the Central Government could do much by taking the initiative and, if necessary, by issuing directives.

CHAPTER SIX

RECLAIMING LAND

No accurate statistics exist of the land in India which could be reclaimed for the production of food and other crops. Presumably, the 93 million acres recorded in the Ministry of Food and Agriculture's *Land Utilization Statistics*[1] as 'culturable waste' is not all land which needs deep cultivation to get rid of weeds like *kans* (*Saccharum Spontanium*) or which needs an elaborate scheme of drainage, or again land which must be treated for alkalinity or salinity before it can be called culturable. The term 'culturable waste' appears to apply to old fallow and to marginal land which by erosion or bad management has become unprofitable to cultivate. But, in essence, land which can be made culturable by treatment, no matter what that treatment may be, should be termed culturable waste land.

It is stated officially that out of this 93 million acres, only 10 million acres are definitely known to be culturable. Why then is the entire area of 93 million acres classed as culturable waste? The fact is that no one can make a really reliable estimate of the potentialities of this vast area, after 10 million acres of the best of it have been set aside as definitely culturable. Therefore it would be best to regard as culturable waste all areas which by treatment, which will neither be too costly nor take too long, can be made productive. And it would be well to remember that no land can be regarded as productive that does not produce enough to leave a substantial surplus for the farmer, after paying all expenses of production. To get these 83 million acres of doubtful cultivability or productiveness into a condition that would ensure a substantial surplus for the farmer, will take time, effort and expense.

Be that as it may, except in so far as statistics help to get an idea of potential land resources and the magnitude of the task in terms of the number of millions of acres to be

[1] See page 3 (footnote).

improved or reclaimed, it is immaterial to the real object of this discussion how near the margin of cultivation these lands are. India has according to official statistics[1] only some 400 million acres of agricultural land of which 23 per cent is classified as culturable waste land. It is a question of survival; and every acre that can produce food crops, no matter how difficult the process may be, provides the subject for this chapter on land reclamation.

In general, the following four classes of land which are to be found abandoned and uncultivated, are capable, by suitable treatment, of producing adequate returns in cash as well as in kind: Virgin land in malarious or otherwise badly drained, unhealthy and uninhabited areas; land infested with deep-rooted weeds, requiring modern machinery for its reclamation; land which is alkaline or saline; and land subject to constant erosion. It will suffice to consider the various ways of dealing with these in order to make them productive; and since the methods of treatment are fairly well known, the object here is simple—to draw attention to what steps can be taken by way of short-term planning in order to achieve a rapid and countrywide reclamation of this vast potentially productive area.

Virgin Land in Malarious Regions

A good example of virgin and occasionally abandoned land in a malarious region, is the strip of sub-montane *tarai* in Uttar Pradesh. Until recently, this region was badly drained, very malarious and sparsely inhabited. A few herds of cattle were to be seen grazing on pasture, and here and there were patches of cultivation. This was as unhealthy a tract as any in India and its vast plains of virgin land were covered with deep-rooted grasses and were for the most part badly drained. Mosquitoes and disease germs flourished. In the short space of five years, a large part of this *tarai* area in one district has been transformed by a well devised and wisely directed plan drawn up by the Uttar Pradesh administration. Anti-malarial operations have reduced the incidence of malarial fever to almost nil. Roads and buildings have appeared and mechanized farming has produced heavy yields of food crops over a large area where it once

[1] See page 7 (footnote).

seemed impossible ever to get people to live and flourish. The expenditure on this venture has been more than justified; for not only are the dividend returns substantial, but thousands of tons of food are being produced and the countryside is becoming populated, relieving the congested areas from which the agricultural labour has been largely drawn. Here is a practical demonstration of what can be done with reclaimable land: It is of inestimable value. Let this excellent work be repeated all over India, until not a single acre is left abandoned because of bad drainage or unhealthy conditions.

Water-logged areas are, however, by no means confined to sub-montane territory. Cases of badly drained land are often found more inland. Very often these water-logged lands were once rich fields, but have gone out of cultivation because of faulty planning and execution of badly designed schemes of railway and highway construction. These lands, now soured, can be reclaimed by the simple expedient of drainage. Making culverts, drains, pumping up water and the like will, of course, involve expenditure; but it will be found to be nationally profitable to make a survey, as early as possible, of all such reclaimable land. Let each state undertake these surveys, estimating expenditure and constructing drains and culverts until every acre which has become soured by water-logging is reclaimed for profitable agriculture. And let this form part of a serious national drive for self-sufficiency in food, and let those in authority act with wisdom and with speed.

WEED-INFESTED LAND

The second category of reclaimable waste land, namely that infested with *kans*, a deep-rooted grass, has been tackled by the Central Government; and if the Five-Year Plan is completed to schedule, millions of acres will have been either reclaimed or improved by 1956. Other deep-rooted weeds are mostly controllable by means of the cultivators' own implements; but *kans* needs the drastic treatment which heavy tractors and deep modern ploughs alone can provide satisfactorily, except in rice-growing tracts where it can be drowned. The roots of this weed form a matting some 12 inches below the surface, and it is only

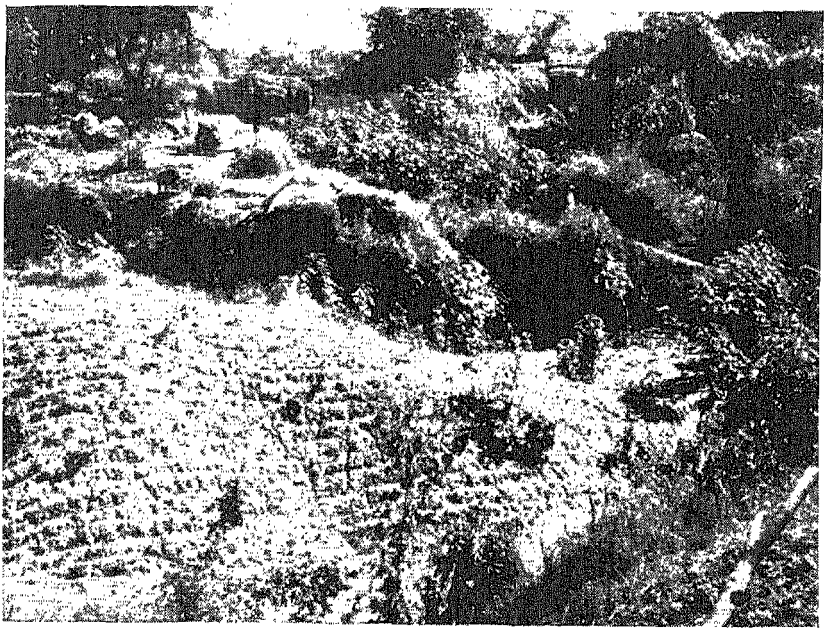
when they are dug up and exposed to the scorching sun that they die, unless drowned or choked as in rice fields. Otherwise each root node will form a fresh *kans* plant. It is devastating in its effect on agriculture, for it seems to spread rapidly, gradually strangling the efforts of the farmer to grow crops in those parts of his fields which are comparatively free of the weed. The ploughing provided by tractors digs 12 inches and more into the rich soil, with the result that in addition to the weed being killed, the yields of crops are improved both under dry and under irrigated conditions.

The main solution after deep ploughing is to keep the land properly cropped and cultivated and so prevent the reappearance of the *kans* shoots above ground. Otherwise the formerly infested land is liable to become infested again. The State will have to take special steps to see that this does not happen, or the vast sums spent on reclaiming or improving these lands will have been spent in vain.

The expedient of drowning this noxious weed by capturing monsoon water in the fields and keeping it there long enough is feasible; but it needs initiative, and this is not always forthcoming in cultivators to the desired degree. The same applies to digging out the weed by hand. It is improbable that the Five-Year Plan covers the entire area threatened by *kans* infestation in India, but the good work begun by the Central Tractor Organization must be continued. The various state governments will have to make accurate surveys of lands needing the drastic treatment provided either by this Organization or by a Land Development Corporation (see chapter eleven). They will further have to see that wisely planned cultivation subsequent to deep ploughing by tractors, keeps the weed from reappearing.

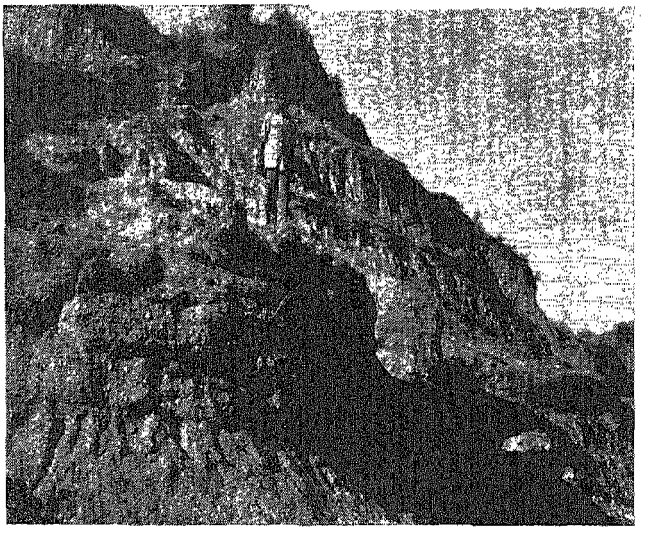
Alkaline (Usar) Land

The third category of land in need of reclamation is perhaps the most interesting. Alkaline and saline lands, like *kans*-infested lands, are, from the point of view of this discussion, of two main classes: those that are fairly easily reclaimed and those that need more drastic treatment. In the former case, 'land improvement' would probably be a fitting description of the operations needed, while in the



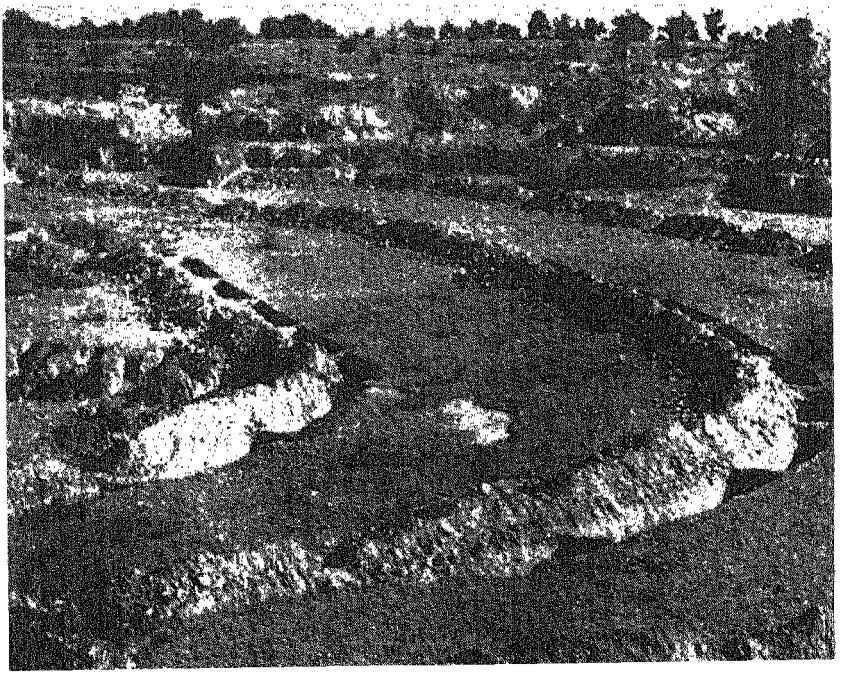
Cultivated slope near a riparian hamlet. No attempt has been made to prevent erosion by terracing. That is the beginning. . .

and this is the end. Vast areas of valuable alluvial land along our river banks have been laid waste by neglecting ordinary precautions against erosion.



This is what happens to the uplands bordering on our main rivers if erosion is not taken in hand in time.

Efforts to save by afforestation what is left of badly eroded rocky land bordering on Central India. Observe the pits prepared for planting hardy trees against the slope.



latter, more difficult case, the term 'land reclamation' is more appropriate.

Here again no reliable statistics are available of the areas actually affected by the presence in the soil of alkaline or saline salts, or of the extent of the infection. All we know is that such areas as are affected and can be improved or reclaimed for profitable cultivation run into millions of acres, and that it is well worthwhile taking up the work of reclamation on a national scale. Once improved or reclaimed, these lands grow good crops of rice, a badly needed cereal grain in India and in fact in the whole of South-east Asia.

Dr B. K. Mukerji, an authority on *usar* land, a name given to soils suffering from alkalinity, divides these soils into three groups. In the first group are mildly alkaline and easily reclaimable soils with a pH of 7·6 to 8·5. In the second group consisting of moderately alkaline soils, which are more difficult to reclaim, the pH varies from 8·7 to 9·4. In the third group, the pH is from 9·4 to 10·8.[1] The difficulty of reclaiming this last group precludes it from the present discussion which is only concerned with the steps that can be taken with the reasonable hope of a substantial increase in India's food-producing capacity within a short time.

Mildly alkaline soils occur either in areas completely abandoned or in patches on normal soils. These patches sometimes take up a large part of the field and therefore make cultivation and other field operations difficult, rather similar in effect to patches of the noxious weed *kans*. It frequently happens that the farmer cultivates these patches, ignoring them because they are small, and scatters seed on them as in the rest of the field. But when the crop comes up it is patchy in growth, the barren patches corresponding to the presence of *usar*.

Mukerji suggests three cures. First, the application of heavy doses of water to wash away the injurious alkali salts. But water is not always available and if it is taken from ordinary wells, it is frequently itself alkaline. The second and third methods are agronomic and chemical, the former involving the growth of suitable crops or plantations and the latter the application of such chemical correctives

[1] *See* Report of the *Usar* Land Reclamation Committee (Government of the United Provinces, 1938-9).

to the soil as gypsum, calcium chloride and sugar factory press mud. Experience has shown that for soils of the mildly alkaline kind, a combination of the mechanical and the agronomic methods is fairly effective, and that where the alkalinity is more pronounced, some chemical corrective in addition is necessary. The agronomic approach is feasible and largely effective, but the application of chemicals is at present much too expensive to consider for large-scale reclamation. Sugar factory press mud is very useful; but the high cost of transport prevents the large-scale application of press mud to areas far distant from sugar factories. Dr N. R. Dhar[1] considers molasses applied in large doses to be a cure for such alkaline conditions; but here again the approach presents the practical difficulties of transport and handling.

The most effective and practicable remedy to apply to alkaline conditions depends firstly on the amount of alkalinity present and secondly on whether this condition affects fairly large blocks of land more or less uniformly, or whether it occurs in patches within fields which are otherwise productive. Let us first consider the latter. Patches of *usar* are more common in some parts of India than are patches of deep-rooted weeds. The patches may take up anything from 10 to 50 per cent of the area under the plough. Their presence adversely affects agricultural production in that the farmer ploughs up the patches and scatters seed on them simply because it is too much trouble to demarcate them and to avoid ploughing or sowing them. Therefore both labour and seed is wasted. The remedy lies in a realistic approach: to demarcate the patches with pegs made from the waste woody stalks of *arhar*, cotton and other such crops, before the harvest of the crop actually occupying the field. During the early part of the rainy season, assuming that we are dealing with dry or non-irrigated land, these patches should be ploughed up or dug up by hand, depending on their size and shape. The rain will then soak into them and wash down much of the injurious salts. A month or so after the commencement of the rains, the farmer should apply a fair amount of cow-dung or other organic manure

[1] N. R. Dhar and S. K. Mukerji: 'Alkali Soils and their Reclamation' (*Agriculture and Livestock in India*, 1936), vi. 850.

to the patches under treatment. Where the patches are large enough for a plough, green manuring with *dhaincha* or *sann* hemp, two useful legumes, will usually have excellent effect. The crop must be ploughed in during the rains, when the stems are still supple, preferably during the first half of August. The very first crop taken from the field thus treated will be an improvement on the previous one. Gradually, as the treatment is repeated each year, the patches of alkaline soil will disappear. Where irrigation is available the disappearance will be quicker, especially if press mud or heavy doses of bulky manure have been applied. Barley is a good crop to sow immediately after the rains, if moisture conditions permit, because it is partially resistent to mildly alkaline conditions. For large areas completely or almost completely abandoned because of the presence of alkali salts in the soil and their effect on production, the treatment is somewhat different though chemically very similar.

It must be borne in mind that the worst kind of *usar* soils are not being considered for the moment as they present a much bigger problem, namely one of breaking through the hard impervious layers of *kankar* or crude calcium carbonate or even hard clay, penetrating to the great depths which prevent rain or irrigation water from draining away injurious salts by the normal process of percolation as is common in all healthy and well drained soils. For this class of soil, it will suffice to indicate that the remedy is a long-term one. The roots of trees and shrubs help to restore normal soil drainage in such soils. Gradually, grass appears under the trees and in this way the bad *usar* is reclaimed over a number of years for grazing and afforestation. The following actual case of a cure for such alkaline soil is instructive.

Bishan Man Singh of Bilanda Farm, Fatehpur, Uttar Pradesh, tells of his experience in reclaiming *usar* land, and this is so valuable that it is reproduced here in some detail. He tells the story of what actually happened to about a square mile of moderate-to-bad *usar* land acquired in 1903 and classified in government records as unculturable waste land or *ghair mumkin*. A low barrier about one foot in width and the same in height was erected round this area with the object of demarcating it. During the rains, because of the

impermeability of the surface, water was held on the land by this barrier surrounding it. This seemed to help to wash down injurious salts, for gradually grasses like *kans* and shrubs like *jharberi*, a wild *jububa*, *babool* and *madar* began to appear. The last mentioned, the *madar* plant, the seed of which is blown about in the wind, was found to be of special interest, because 3 to 4 feet round the plants good grazing grasses began to flourish. Grazing was controlled to allow these grasses to spread. Seeds of the *babool* tree, a hardy acacia, were sown regularly every year and, although to begin with germination and subsequent survivals were poor, in about ten years a good plantation of these trees was secured. Under the trees was ample evidence of grazing grasses and perennial weeds, the roots of which helped to open up the *usar* soil. It was observed that *babool* trees flourished when the seed was planted near *madar* plants and that those seeds which were collected from the droppings of cattle germinated and flourished better than seed collected direct from the pods of the tree.

By 1930, the reclamation of this fairly bad *usar* land was a complete success in so far as afforestation and good grazing were secured where nothing grew before. But an attempt made, over some 40 acres of this area, to grow cereals failed because the wild shrubs and grasses flourished and crowded out the cultivated plants. A few *babool* trees would still dry up each year, but there was no trace of a hard pan of *kankar* in the subsoil when dug to a depth of 8 to 9 feet, where the drying occurred. By 1934, Bishan Man Singh was securing remarkable yields of rice on this very area where cereals had failed before. He attributes his success to the building of a substantial embankment round the area on three sides towards the lower end. This held up rainwater brought in from higher ground. The water was let out periodically up to the middle of August by making cuts in the embankment, the cuts being repaired as soon as the water, containing injurious salts, was drained out. The area was puddled for a late paddy crop after heavy doses of farmyard manure had been applied. Before puddling, the *kans* and *jharberi* plants which had appeared were cut by large sickles and did not appear again because, with water standing on the area, the paddy plant could flourish, but the roots of the others

were suffocated. Very good yields of a local coarse paddy were secured in this way—as high as 50 maunds, or over 4000 lb., per acre—and in 1938-9 when the monsoon was good, a second crop of barley, gram and wheat was taken after harvesting the paddy. It was found that in this process perennial weeds completely disappeared. Another curious phenomenon was that large cracks appeared all over the fields after harvest. At the present time this area is manured heavily each year with farmyard compost to which a light dressing of slaked lime is added to help make the soil friable.

That briefly is the story of the reclamation of a square mile of moderate to bad *usar*. It is a long story, but it has an important bearing on the subject of reclaiming India's vast plains of *usar* for food production. For if the moderately alkaline lands are left untreated and uncared for, they will be grazed indiscriminately as soon as any grass appears thereon, when herds of hungry cattle, half starved during the hot, dry months preceding the break of the monsoon, will rush to pick up the first young shoots of green grass that appear with the advent of the rainy season. The already partly impervious soil, laden with injurious salts, will become more impervious by the puddling effect of the numerous hoofs of hungry cattle trampling it, as indeed happens, and its ill effect goes on from year to year.

The remedy applied at Bilanda can be applied over millions of acres. It is a question of organized demonstration and controlled grazing. What took thirty years to achieve at Bilanda on moderate-to-bad *usar* may take less than five years on mild-to-moderate *usar*. Let the work of improvement and reclamation of alkaline soils be taken up seriously by the State, as part of both short- and long-term food production plans. There is ample experience and experimental data to work on.

Saline Land

In addition to reclaimable alkaline lands, there are vast areas affected by salinity, mostly in canal-irrigated areas. Sodium sulphate in large quantities characterizes the Punjab saline lands and sodium carbonate those of Uttar Pradesh. The problem here is simplified to some extent by the fact that saline soils generally occur where the subsoil

is porous and allows the leaching out of harmful salts. Deep cultivation and the growing of resistant crops like rice or cotton have given good results. The fields are embanked in blocks of a quarter of an acre each and water is kept standing in them. The water is drained off from time to time, each time fresh water being impounded. This process of leaching is continued for about two months, after which rice is sown, early in June. If salinity should reappear in subsequent years, the process is repeated. This method cannot generally be used in Uttar Pradesh because of the presence of impervious subsoil which precludes ordinary leaching. But even in Uttar Pradesh there are large areas, commanded by canals, where the salinity is caused largely by the rise of the subsoil water table. Fortunately the subsoil is often permeable in these areas, and leaching, as in the Punjab, can be practised with benefit. The use of organic manures like cattle-dung and green manure as additions to leaching and deep cultivation has been successful in reclaiming areas such as these.

The fourth group of lands in need of reclamation, namely lands subject to erosion, has already been discussed in an earlier chapter. It is of far greater importance than alkaline or saline lands, but the remedy for erosion is simple, and the results quick.

* * *

The foregoing discussion is mostly of short cuts to the reclamation of the four major classes of potentially productive land which for one reason or another has become unproductive. There are two further classes of land for which long-term treatment is necessary. Not all of the land thus categorized can be classed as culturable waste; but it can be made use of for two important national purposes, namely grazing and afforestation. Since both the land available for grazing and that on which fuel and other wood is produced, fall far short of the national requirement, it is desirable that the subject be examined.

Unproductive Grazing Land

Taking first the potentially productive grazing lands, it is a common sight during the first fortnight of the monsoon to find, on green patches of the large plains, stray herds of

cattle wandering about trying to pick up what grass they can. As has already been stated, they are so hungry that they rush to the grass as it struggles to appear and rapidly devour it.

It is interesting to examine why this grass is in patches and not uniformly distributed over the entire area. In the first place, one has to remember that grasses have a severe struggle for existence in any grazing area where the rainfall is concentrated over 3 or 4 months of the year, for during the remaining 8 or 9 months these grasses tend to dry up. In the second place, a heavy concentration of a vast cattle population prevents recovery by trampling wet ground and by over-grazing during the first two or three weeks of the monsoon. It is true that the droppings of dung and urine help to stimulate the growth of grasses; but the effect of drought and trampling is disastrous.

The only effective way of dealing with this state of affairs is to prohibit any grazing of these areas for one, two or three monsoon seasons, taking the cattle to more distant areas or providing them with hay or straw from surplus areas. This will be difficult at first, but unless firm action on these lines is taken the situation will continue to deteriorate. With the development of intensively farmed areas and the expected increase in the yields of cereal crops there will be a surplus of *bhusa* (trampled wheat straw), rice straw, legumes and other crops, which could be baled by machine and transported to the areas where cattle are highly concentrated. This bulky fodder, combined with whatever safe grazing is available locally, should tide over the difficult period of reclamation of the grazing grounds.

Fencing would unfortunately be too expensive on a national scale, unless foreign aid for this specific purpose was forthcoming under one or other of the current plans for economic aid to India. Anyway, fencing alone is not sufficient. Village watchmen will, amongst others, have to be responsible for keeping these areas absolutely free of cattle during the period of reclamation. Reclamation could, of course, be accelerated by the scattering of grass seeds, together with small quantities of well rotted and finely divided compost or other bulky organic manure, over the area during the early part of the monsoon. The success of

this method will however depend very largely on the amount and distribution of rainfall after the seed and manure have been scattered. Should the rain be inadequate in quantity or badly distributed, the process will have to be repeated the following monsoon in the hope that the rainfall will be more satisfactory.

When finally the grass has been established, it would be well to graze it gradually or by rotation so as to avoid causing a repetition of the trouble. Rotational grazing implies the control of the cattle moving over the grazing area in such a way that at no time is any part of it over-grazed. And the cattle must not be allowed to enter the grazing area too early, when the grass is as yet young and the ground wet. These measures apply to the plains: In the fertile sub-montane grazing areas, there is never any danger of the grasses being over-grazed or of the cattle entering when the soil is too wet, for in these parts the grasses are rich and so thick that they can resist the trampling of cattle. Also, as the soils are usually deep and clayey, the cattle will not risk the discomfort of entering the wet spots, especially when there is ample high ground free of excessive moisture where the grasses are rich in growth.

The same applies to the hills of India where, in general, the forests provide adequate grazing all the year round. There are places, however, in the hills and sub-montane plains, where the quality of grazing grasses is in need of improvement. The work of Boshi Sen in Almora has shown quite definitely that the legume *kudzu*, imported from the U.S.A., grows luxuriantly in the hills and greatly improves the quality of grazing available. The vines of this wonder-plant can be seen growing to great lengths on almost soil-less rocky projections at the Vivekanand Laboratory, Almora. The luxuriance of the plants attracts cattle and the resultant benefits to the cattle are inestimable. In the states of South Carolina and Alabama, U.S.A., this plant is used to reclaim vast areas where erosion has played havoc. The vines spread so rapidly that the ravines created by erosion are filled by them. The soil-laden water which rushes down these ravines during rainy weather, is checked by a network of *kudzu* vines. The soil is here deposited and the ravines are gradually filled up. Grazing goes on at the same time,

for the vines spread over the rest of the ground as well. In dealing with the improvement, as distinct from the reclamation, of grazing areas in hilly and sub-montane areas where the rainfall is generally adequate and well distributed, it would be well to use plants like *kudzu* which have proved their value, for the purpose.

Another useful plant is the Giant Star grass (*Cynodon Plectostachyum*), imported from Africa and tried with considerable success at Almora and elsewhere. The growth of this grass, which is a giant type of the common *dub* grass (*Cynodon Dactylon*) is extremely rapid and it provides bulky grazing of better quality than most existing grasses. While *kudzu* is a legume, Giant Star grass is not. Nevertheless both are superior in quality to most of the existing grasses and legumes found in hilly and sub-montane areas in India.

SHRUB-COVERED AND ROCKY LAND

The other class of land for which long-term reclamation is necessary, is the vast undulating shrub-covered but mostly rocky areas found in Central India, as far north as Alwar, as far west as Mirzapur, U. P., and near Delhi. These lands are in the process of erosion, but the presence of shrubs and some trees, together with inferior grasses, prevents their being laid waste completely. Goats and sheep wander over these areas, some of which provide shellac and catechu (*kuththa*) as commercially valuable products. In general, however, these areas have been abandoned as hopeless for any productive purpose; and yet there is much that can be done to reclaim them, in parts of this vast tract to begin with, for utilization as potential forest and grazing areas.

The method suggested for adoption under these conditions is simple and inexpensive. Some years ago the members of the Golf Club at Jhansi in Bundhelkhand, anxious to find a solution to the bare rocky hill-tops on the course, presenting too hard a surface to a bouncing golf ball, asked an agricultural expert if nothing could be done to improve matters. He had clay collected and, after kneading it with water, had it applied in strips a few inches high in circles round the rocky tops. This was done just before the rainy season. The clay stuck to the rocky surface like glue and refused to be washed down by the heavy rain which came

up against it, leaving a thin deposit of silt in the angle made by the clay and the rocky surface. Presently there were more showers of rain and more silt was deposited in the same way, until towards the end of the monsoon strips of thin soil a foot or more in width were deposited wherever the clay clung to the rock, and on this thin soil was found a spontaneous growth of green grasses.

The history of mankind is full of instances where some small occurrence, apparently of no great significance, has led to epoch-making discoveries. James Watt observed the cover of a kettle bubbling up under pressure of the steam within, and discovered the possibility of using steam to provide the motive power in a locomotive. Sir Isaac Newton recognized the law of gravity while watching apples drop from a tree. Who can say what revolution in land reclamation the simple method of getting grass to grow on sloping rocky surfaces, might bring about if followed up by an enterprising and far-sighted State? At any rate, since the method is inexpensive it is worth trying.

The soil held up by clayey obstructions will in any case increase the area under grazing grasses. It is also probable that by blocking or plugging ravines at intervals, silting up will occur to such an extent as to open up the possibility of afforestation in these otherwise barren lands. For this purpose it would be wise to divide the millions of acres of such territory into blocks of convenient size, placing each block in the care of a competent official, the entire scheme being controlled by an officer of the status of head of a State Agriculture or Forest Department.

So far as India's desert and semi-desert tracts are concerned, the time may come when some method is discovered of reclaiming them for the use of the nation. W. W. Mackie of the University of Berkeley has evolved a technique of his own for the reclamation of such land in California: He makes the most of dew and rain by the judicious use of the right type of fertilizer. The problem in India as elsewhere is a long-range one. It needs careful study and research. Science has achieved wonderful results in so many fields that India should not despair of finding a way to reclaim semi-desert, if not completely desert, tracts for grazing, afforestation and even for arable farming.

CHAPTER SEVEN

DRY FARMING

INDIA'S agricultural production depends more on dry or rain-fed farming than on the comparatively small area under irrigation. Out of the 244 million acres under cultivation, only 48 million acres are at present irrigated; roughly a fifth. Four fifths of the area of this subcontinent depends entirely on the monsoon and a little winter rain for its food as well as for all the other crops grown. Even when the Five-Year Plan has succeeded in achieving its target, only about 8·8 million more acres will have been added to India's irrigated area and, if this is ultimately increased by schemes under investigation, $16\frac{3}{4}$ million acres will, according to present indications, have been added to the 48 million acres already under irrigation. Some 180 million acres will still depend entirely on rainfall to produce the food, fibres, oilseed and fodder needed to support possibly 400 million people and 200 million cattle.

This is a small area to support so large a population; and the monsoon is never reliable. The winter rain is also most erratic, although in the Gangetic Plain the two inches of winter rain if received regularly between mid-December and mid-January, following a normal monsoon, would under present conditions probably result in enough food being produced to meet a large part of the present annual deficit. But neither the monsoon nor the winter rain can be relied upon; and the Indian cultivator has not yet mastered the art of rain-fed farming; nor has anything like sufficient thought, money and time been spent by the agricultural departments of the various state governments on studying the subject.

It was only a few years ago that the Indian Council of Agricultural Research initiated its schemes for research on dry-farming and established centres for this purpose at Raichur, Sholapur and Bijapur in Bombay Deccan and at Rohtak in the Punjab. Some work has also been done at

Bharari in the Jhansi district of Uttar Pradesh. These centres are not in themselves, however, sufficient for the 196 million acres on which dry or rain-fed farming is of necessity practised.

No work has been done on the desert and semi-desert lands of Rajasthan where cultivation of a sort is carried on in patches, nor have the rice-growing tracts been tackled in earnest from the point of view of making the maximum use of the heavier rainfall they receive. The vast wheat-growing areas of the Gangetic Plain present their own peculiar problems of conserving moisture and of getting the maximum benefit of whatever rain is received either directly from the clouds or from the rivers that flow through this great granary of India. The only really valuable work done on river irrigation is that of C. H. Parr who showed how to increase yields by running the surplus water off rivers into canals and thence to *rabi* fields and by making it stand in these fields from early August to mid-September, in order to increase the available moisture for the subsequent wheat or barley crop brought to maturity under rain-fed conditions. There is no doubt, however, that what work has so far been initiated is valuable, and some of the main conclusions arrived at in official research centres are discussed here.

Opening up the Soil

It is observed that *fields intended for dry* rabi *or winter crops should be opened up prior to the monsoon by ploughing or sub-soiling so as to make possible the maximum absorption of water during the rainy season.* This is perhaps the most important conclusion and is one which merits adoption for the entire area represented by the experimental station where this work was carried out, if not further afield, even though in actual practice there are certain obstacles to be overcome before the farmers can take to this sort of cultivation. The chief of these is that during the period between the *rabi* harvest in March and the advent of the rains in June, bullock- and man-power available is busily engaged in threshing; the laborious process of treading straw to convert it into small smooth pieces (*bhusa*), and in winnowing. (Winnowing is largely dependent on wind and often takes a long time to finish.) By the time the grain has been bagged

and the *bhusa* stored, the soil is often so baked and hard that opening it up is physically impossible with average-sized bullocks.

There are two solutions. The first lies in opening up the soil immediately after the *rabi* harvest. This is most important because evaporation from the harvested field in the hot and dry months following harvest causes a hard and dry crust to form, and this crust gets thicker and deeper every day. In the absence of more suitable implements the grower has to depend on the *desi* or indigenous plough; and in light soils this implement will do the job, though not adequately. But in heavier soils a light steel plough that will leave the land in a cloddy condition has been known to give much better results. The second solution depends on quick threshing and winnowing with simple machines like the Olpad thresher and the hand-winnowing machine. This will release the necessary bullock- and man-power for timely cultivation.

Where tractors are available, a sub-soiler which makes an incision in the soil without opening it up too much is often useful under certain conditions. A bullock-drawn rooter has also proved useful in clayey loams. But perhaps the quickest way to deal with a fairly large area is to use a modern bullock-driven cultivator. The need for this and other suitable bullock-drawn implements is apparent. In the matter of design the Allahabad Agricultural Institute has done very valuable work and much useful advice is available there on the use of steel implements drawn by bullocks. For post-*rabi* harvest operations on fairly heavy loams, a steel plough with a moderate size mouldboard is recommended by the Institute. The hot winds preceding the monsoon tend to have a harmful effect on the soil, which becomes too dry, often causing loose particles to be blown about. Local soil and climatic conditions will dictate what implement will give the best results for post-harvest and pre-monsoon cultivation in each village. In most cases such cultivation is preferable to leaving the field untreated until the rains come.

Opening up the soil immediately after harvest has many advantages. Apart from the beneficial effect of incorporating the *rabi* stubble into the soil and increasing nitrification, the

soil is thus prepared for the absorption of the monsoon rain. A further distinct advantage is that the seeds of a green manure crop like *sann* hemp can be scattered in the field before the rains set in. An early start for this crop is thus ensured and it is ready all the quicker to be ploughed under. If a crop like maize or *juar* is desired, it will benefit greatly from pre-monsoon cultivation.

In a previous chapter, embanking to secure greater absorption of water for soil and underground supplies has been discussed. Absorption would be further facilitated by pre-monsoon cultivation. Also, the heavier showers of rain will tend to level up slightly uneven portions of each field. Excessive accumulation of water can always be run off from time to time ; but under rain-fed conditions the more moisture the better, except where clay soils tend to become waterlogged. Embanking and pre-monsoon cultivation, the two main methods of capturing the maximum amount of precipitation, deserve the earnest attention of all who sponsor increased production under rain-fed conditions.

PLOUGHING

Secondly, official research centres confirm the remedies already stressed in these pages, in recommending the *bunding or embanking of fields to stop surface run-off and to ensure the subsequent increase in the moisture status of the soil* ; and, similarly, the affirmation that *fields should be ploughed with an implement during the dry months preceding the monsoon* coincides with what has just been said regarding the use of suitable implements.

The indications apparently are that, for light soils and alluvial soils generally, shallow ploughing is to be preferred to deep ploughing. Under most dry-farming conditions, a sub-soiler used before the monsoon secures the necessary moisture for soil and subsoil without harming the surface soil by too much exposure to the extremely dry and hot conditions during the two or three months preceding the monsoon. In soils other than rich clay, exposure is undesirable, and for these a light ploughing is advocated.

Pre-monsoon ploughing with a soil-inverting plough under dry-farming conditions is fully justified where rainfall is ample and the texture of the soil heavy; or, during the

rains, where weeds have to be eradicated with the aid of the plough. The eradication of weeds is, however, achieved automatically wherever water, held up by bunding, stands in the field. When heavy rain occurs and a good deal is absorbed into the subsoil, there is generally a surplus that makes conditions too wet for weeds to flourish.

It is best to use a cultivator immediately after harvesting the *rabi* or winter crop, and a light *desi* plough immediately after the *kharif* or monsoon crop has been harvested, where the soil is of light texture. The multi-tined cultivator is a useful implement because it does not open up the soil too much, and the areas to be treated can be covered at three to four times the speed of the *desi* plough. Speed is important because the longer this operation is delayed after the harvest, the harder will the soil get; and the harder it gets, the more difficult it is for the point of the implement, whether plough or cultivator, to penetrate the surface soil.

PLANTING THE SEED

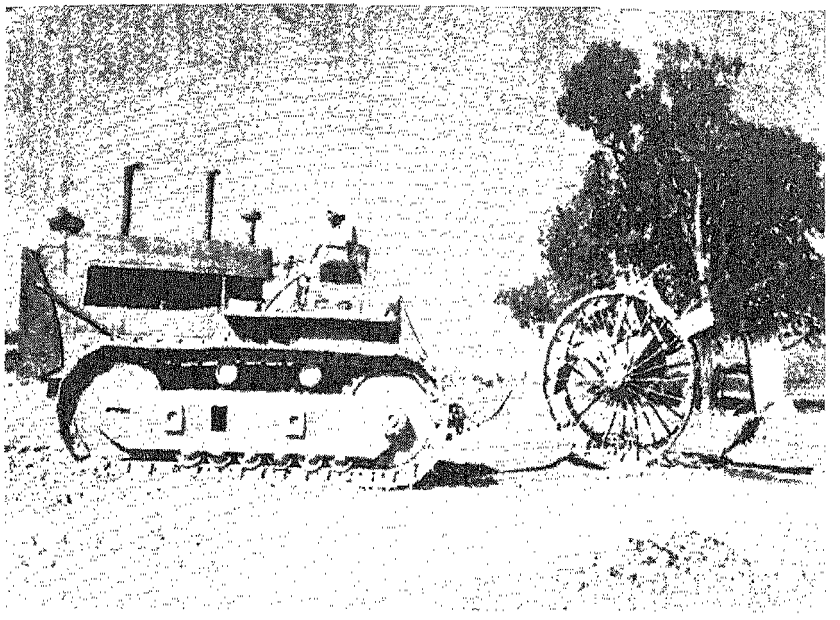
Two further conclusions reached in the research centres are so closely linked that they might be discussed together. The one asserts that *mulching of the hard dry crust of the surface soil should be done by interculture between rows of the growing crop to reduce to a minimum loss of moisture due to evaporation.* The other suggests *widening the spacing of rows from 12 to 18 inches for the purpose of partially creating a fallow effect.* Both might well be modified in the light of experience gained by others. In general, mulching has more than a moisture-saving value: Weeds are kept down and plant growth is stimulated. For spacing between rows, 12 inches for *rabi* and 30 inches or more for certain *kharif* crops give good results. Both conclusions involve the use of a seed-drill in the first instance or, possibly, dibbling by hand on carefully drawn straight lines in cases where the field is too small or irregular in shape for the use of a seed-drill or even for sowing by means of dropping the seed behind the plough.

One of the most disappointing aspects of work done by various agricultural experts during the past half century, is the fact that none of them have evolved a really first-rate seed-drill suitable for use by the dry farmer on a small

holding. The seed-drills of modern design in use here and there on a very small scale are either too complicated or too expensive for the Indian farmer. On large fields, existing seed-drills can be used to a limited extent, but if fields are to be bunded or embanked, the seed-drill must be a light and simple device that can be lifted easily over the embankment going from one field to another. Perhaps a two-pronged drill of the hollow tube type, in which the seed rate per acre could be controlled and any number of seeds deposited at the optimum depth in each line, would be the answer. Now that research workers on dry farming have suggested 12 to 18 inches as a suitable distance between rows of crops, it ought to be possible to perfect a seed-drill.

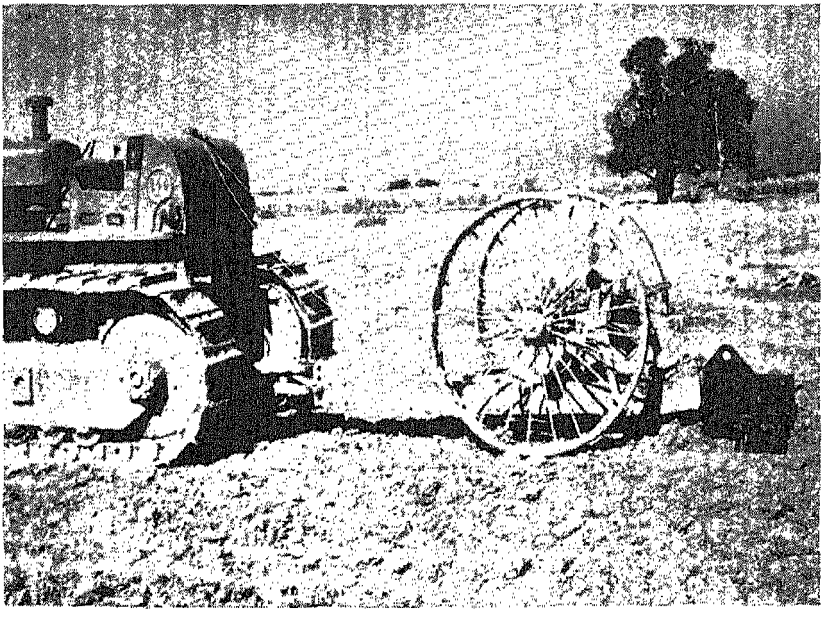
It must be borne in mind that in dry farming, getting the seed into the soil within the short time usually available between showers of rain is a tricky business demanding both care and speed. Therefore, if sowing in rows is to become a generally accepted practice, the seed-drill used must be one which the grower can manipulate with ease and with good effect. It must also be simple and cheap. Perhaps if sufficiently large prizes were to be offered for seed-drills suitable for different kinds of dry-farming conditions throughout India, people with inventive minds would be induced to find the answer to this problem. Till then, the age old practices of broadcasting or scattering the seed, or dropping it behind the plough or, at most, using the improved country-made seed-drills, will continue. Recently a three-pronged seeding attachment to the 'Wah Wah' and 'Shabash' cultivators, introduced to the market by the Agricultural Institute, Allahabad, has given good results. This type of simple but effective seed-drill might well provide the answer to the conditions prevailing in North-west India. The future development of bullock-drawn implements must necessarily depend on efficiency combined with cheapness and simplicity.

It is difficult to estimate what effect the use of a really suitable seed-drill for grain crops would have on food production under dry-farming conditions. One can only discuss the effect that raising grain crops in rows with the help of inter-line culture, would have on the all-important factors of moisture and nitrification. Row plants receiving interculture are much better developed and are likely to give



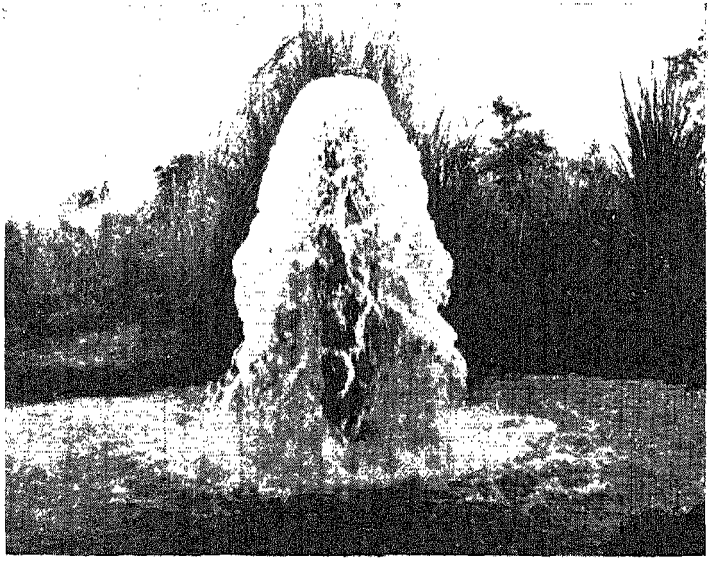
A sub-soiler, hitched to a tractor, is about to enter the soil. Observe the shape and size of the implement which is of definite value under dry-farming conditions.

The sub-soiler has been drawn into the soil and subsoil to a depth of about 2 ft. A lighter sub-soiler for use with bullock-power would be a valuable innovation.



Arhar, a lentil (*Cajanus Indicus*). On the left is a heavy-yielding tall variety and on the right an inferior dwarf variety. *Arhar* plays an important part in crop rotations in dry farming.

An artesian well. A tube bored 150 to 500 ft into the earth's crust sometimes meets water under pressure enough to send it above ground like this. Usually, however, it is only enough to send the water to within 30 to 50 ft of the surface.



considerably higher yields than those raised by merely scattering the seed and waiting for the crop to mature; and this is one of the improvements which would make all the difference between unscientific and scientific farming. The food situation demands as speedy a transition as possible from the one to the other.

As row planting must be accompanied by inter-line culture to get the best results, the next question to consider is the implement most likely to give greatest satisfaction in stirring the soil between the rows of plants. Such an implement must do two things. In the first place it must stir the soil lightly without damaging the young plants, and in the second it must stir the soil without inverting it, for under dry conditions too much exposure to wind and sun may be harmful. Various types of inter-cultivating implement are in use in sugarcane farming, but they are not the type that will necessarily suit grain crops planted in rows. For cereal crops, the multi-tined cultivators of the 'Wah Wah' and 'Shabash' types have given satisfactory results under such conditions as those prevailing in the Gangetic Plain.

An implement in common use in Central and Western India is called a *bukhar* or blade-harrow and is used largely in preparing seed-beds for rain-sown crops. Where cotton is planted in rows, this implement has given good results in inter-line culture. An adaptation of this type of implement might well be the most suitable implement to use for inter-culture, in any case for Central and Western India. The *bukhar* is a blade of hardened iron, made by the village blacksmith and fitted into a wooden frame. It is adjustable as to the depth to which it will stir the soil, more or less in the same way as is the *desi* plough. When the blade gets blunt, it is sharpened by the blacksmith. Its greatest value lies in its simplicity, its cheapness, and its performance. It stirs 2, 3 or 4 inches of soil without exposing it and leaves the soil in a better state for nitrification and for resistance to the evaporation of valuable moisture. It should be possible to devise a two-bladed *bukhar* worked by a pair of bullocks, whereby the spaces between rows of plants could be inter-cultivated. Allowing a 3- to 4-inch safety margin on either side of the plants, a 10- to 12-inch blade should be suitable for working between rows 18 inches apart.

In Uttar Pradesh it is a common practice for growers of *bajra*, one of the lesser millets, to run a *desi* plough through the field when the crop is about 6 inches high. This operation is carried out only once during the entire growth period of the crop. Many plants are, of course, uprooted in the process; but since the operation is carried out during a break in the rains, the subsequent showers seem to revive and set up most of the fallen plants and, what is more significant, this operation secures the farmer a much better crop and a higher yield than he obtains with *bajra* not so treated. The scientific reason for this probably is that the stirring of the soil helps aeration and nitrification near the roots of the plant. The operation also earths up the roots, providing support to the plants and helping the tillering process. This is a good dry-farming practice; but should the same crop be grown in lines and not one but several interline stirrings be given during breaks in the monsoon, the results are likely to be even better. While recent research work recommends mulching the surface soil, other expert opinion is in favour of cultivating rather than mulching between rows. The relative merits of either method depend on certain conditions, and the local expert must be left to choose his implement.

Rotation of Crops

It is further concluded that suitable rotations should be followed and that leaving the land fallow for a year, so as to pass on the soil moisture and plant nutrients to succeeding crops, has beneficial effects. Suitable rotations include those in which a leguminous crop is taken once in two years or so in order to ameliorate the soil with the nitrifying bacteria found in nodules on the bushy roots of the leguminous plants. And the bushy roots themselves add organic matter to the soil when the crop is lifted.

It would be well here to consider briefly the root development of the different crops entering into the rotations selected for dry-farming conditions. Legumes like *lobia* and *guar* during the rains, and gram and peas after the rains, have roots with a bushy growth that leaves the soil richer in nitrogen. Grain and cereal crops like *juar*, *bajra* and maize sown during the rains, and wheat and barley sown

after the rains, have shallow roots that spread out near the surface and which are not bushy as are the roots of legumes. Therefore in a rotation it is well to have these two types alternately, so that the demands on plant nutrients and moisture in the soil are made at different depths. There is yet another class of root, the long tap root like that of the cotton plant and the long bushy ones of the *arhar* plant. These, if included in the rotation, help to open up the soil at greater depths, admitting moisture and air with beneficial results. When the crop is harvested the roots are left in the soil and subsoil and add some much needed humus to the usually meagre supplies of organic matter, which improves the capacity of the soil to hold moisture. Hence, in deciding what rotation should be adopted in any particular area, it would be well to take into account the root system of each crop selected, provided it suits the soil and climate of the area. In any national drive to increase food production in dry areas, suitable rotations will have to be brought to the notice of the farmers concerned by means of pamphlets, demonstrations and lectures.

It has yet to be determined whether in dry farming, under a given set of conditions, it is better to rotate crops or to mix them. For instance, the cereal crop of *juar* can either be sown in rotation with a legume like *arhar*, the latter being sown as a pure crop in the July following the *juar* harvest, or the two crops can be sown together as a mixture. In practice, it is most common to find these two crops in mixture. Further, in some parts of South and Central India, a seed-drill said to have originated in the ceded districts of Madras is used, and a mixture of the seeds of two or three crops of different habits but of about the same growing season, is dropped through the tubes of the drill. The result is a mixed crop sown in lines or rows and this is assumed to be better than a mixed crop in which the seed is scattered at random. In the Gangetic Plain, good results have been obtained by alternating rows of *kharif* crops, especially *juar* and *arhar*, and inter-cultivating between rows 30 inches apart.

It would be useful if research workers on this subject were to tell us which of the following is the most satisfactory practice under a given set of conditions: (a) Mixed seeds

of a cereal plus a legume, sown in rows 12 inches apart for *rabi* and 30 inches apart for *kharif* crops and inter-line cultivated; (b) the same seeds sown as pure crops in rows over two separate seasons with a fallow during the winter season, or (c) the scattering of seeds of a cereal like *bajra*, followed by the use of the *desi* plough in the standing crop when the plants are about 6 inches high, and this followed further by a legume sown in rows in the following season.

Research takes a long time to establish any results which can be usefully applied in practice. While research work must therefore continue as a long-range plan, the knowledge already available on the subject of row planting, rotations and the like, must be demonstrated on cultivators' fields. For to increase the yield per acre from India's dry-farmed areas is a matter of the utmost urgency.

Use of Bulky Manures and Fertilizers

Another observation made by research workers in dry farming is *that the manures required vary according to the crops grown and the nature of the soil.* It is a well known fact that bulky manures and chemical fertilizers require plenty of moisture to be of any use in farming. In fact, if under dry-farming conditions manures and fertilizers are used without adequate knowledge of their effects under these conditions, there is a danger that all or nearly all of the available soil moisture will be used up in absorbing the manures and the crops grown will die as a result. In countries where rainfall is spread more or less evenly over the growing season, heavy manuring is practised without any fear of the soil moisture being inadequate for the manures or fertilizers used. No irrigation is necessary in these countries. In India, the greatest care must be exercised in the application of manures to crops grown under rain-fed conditions; for although the rainfall is often over 30 inches, the period during which this rain is received is 3 months or less, so that the remaining 9 months may be dry or nearly dry. It is true that from 1 to 2 inches of rain is received during December to February in most parts of the dry-farming plains; yet this small quantity of rain, coming as it does after a completely dry period, is not sufficient to warrant the indiscriminate use of manures and fertilizers.

DRY FARMING

It would be well for the purposes of this discussion to divide the dry-farming plains of India into three categories : First, areas of heavy (over 35 inches) of monsoon rain—such as are found in Orissa, Bengal, Assam, Madras, Mysore and parts of Bombay ; second, the very dry belts where the total rainfall during the year is less than 15 inches, and lastly the areas of medium rainfall (15 to 35 inches) comprising the rest of the dry belts. Now it is well to remember that, throughout India, over 90 per cent of the entire annual rainfall is received during the months of June to October. For the rest of the year there are long drought periods of from 3 to 7 months at a stretch, and the losses of soil moisture by evaporation are therefore very heavy. As bulky manures and fertilizers require ample soil moisture to be of use to crops, they must be applied mostly during the wet months of June and July, application in August being to risk the early cessation of the monsoon.

The only exception is in the application of bulky manure to certain *kharif* crops just before the monsoon and in the fertilizing of the rice crop. In July and August when the water stands a foot deep in rice fields and continuous rain or poor fertility causes the crop to turn yellow, a few pounds of ammonium sulphate sprinkled into the water turns the crop green and this has a remarkable effect on yield. In Madhya Pradesh, in the eastern districts of which the main crop is rice, a small dressing of 30-40 lb. per acre of ammonium sulphate, makes all the difference between a poor and a good crop of rice, if it is applied during July and August when the plants often turn yellow. In the rice-growing tracts generally, heavy manuring with cattle dung is often given in anticipation of a normal monsoon. Should the monsoon be weak or a failure, this manure is not lost entirely, for the residual effect of it is apparent in the subsequent crop. For the important cereal crop of rice, therefore, heavy manuring with bulky manures and with fertilizers is a safe investment, likely to yield good dividends, all over the dry-farming tracts. For other rainy season cereal crops like *juar* and *bajra*, the application of bulky manures should be decided only after a careful study of the soil and moisture conditions. These crops are sometimes grown in the wet belt of over 35 inches of rainfall; and in some parts, especially the

Gangetic Plain, where the soil is mostly a loam or light loam, *juar*, *bajra* and maize are about the only cereals sown during the monsoon. Manuring for these crops is rare, but if the monsoon could be relied on, it would become a common practice. In general, the use of moderate quantities of manure for these two important cereal crops is beneficial wherever line sowing and subsequent inter-line culture is practised. Under these tillage systems, the chances of the manure being incorporated into the soil are better than under the older practice of scattering the seed. Generally, however, the cultivator depends on the recuperative effect of legumes in the rotation, or on moisture, and does not apply any manure. To teach him the value of conserving moisture by embanking and inter-line culture, and the use of manures for cereals like *bajra* and *juar*, is therefore most important, and this can only be done by extensive demonstration on his own fields. On sandy soils, where *bajra* is often grown, even if the rainfall is over 35 inches, the application of fertilizer is generally ruled out on account of the very heavy leaching that takes place, but in places where the soil has improved, bulky manures and even fertilizers can still be applied in moderate quantities with good effect, especially where suitable rotations and the use of light dressings of well rotted manure have been practised for some time.

Taking the very large tract with a rainfall of between 15 and 35 inches, if the use of sub-soilers and embankments to capture the maximum precipitation for the soil and subsoil was to become an established practice, the use of bulky manures and commercial fertilizers could be advocated with impunity, especially if line sowing and inter-line culture were also to be commonly practised. Till then, however, the use of bulky manures and fertilizers will depend on local soil and moisture conditions and will have to be restricted.

In brief, for monsoon-sown crops, the moisture available in the soil should determine the quantity of manure to apply and when to apply it ; and the practice of row or line sowing and inter-line culture helps the absorption of the manurial ingredients into the surface soil.

For very dry conditions (rainfall below 15 inches), it is safest to rely on suitable rotations and mixtures rather than

use manure and fertilizers. In general, leaving the land in bare fallow without a mulch on the surface, is uneconomic, unsound, and should be avoided ; this applies to all rain-fed areas. Wherever moisture conditions permit, however, a light dressing of bulky but finely divided manure can be beneficial, if properly incorporated into the soil.

Emeritus Professor Mackie of the University of Berkeley, California, has for some years been successfully demonstrating the use of manures and fertilizer under semi-desert conditions where the rainfall is under 10 inches per annum. His technique consists in the application of small quantities of manure and fertilizer to drought-resistant grasses and legumes on poor pastures, until the combined effect of better vegetative growth and suitable doses of fertilizer, given at the right moment, improve the water-holding capacity of the soil. This technique is well worth experimenting with under semi-desert conditions in India.

Rabi Crops

So much for monsoon-sown or *kharif* crops. Let us now consider for a moment the possibility of utilizing soil moisture for winter or *rabi* crops, under dry-farming conditions. In the areas of fairly heavy rainfall (35 inches and over), where the soil has a clayey texture, the main crop is usually rice. But over a fairly large part of these areas the soil is unsuitable for rice and therefore a crop of wheat, barley, gram or oilseeds, or a mixture of some or all of these is taken during the winter or *rabi* season. The farmer usually keeps his fields cultivated during the monsoon, and soon after, from the end of September to early November, he sows his *rabi* crop. There are several ways in which he could increase his yield and improve his soil. In the first place, it is generally possible to take a catch crop with or without manuring between the end of June and the end of September, i.e. before the main *rabi* crop is sown. This catch crop should be a legume ; *sann* hemp for green manure or *guar* or *lobia* for fodder. The roots, stems and leaves of the *sann* hemp crop ploughed in early in August rot and provide the soil with much needed organic manurial strength. If *guar* or *lobia* is taken for fodder, the roots of these crops also, if left in the soil, improve it ; and with the help of the nitrogen

provided by the bacteria from the nodules of these roots, the subsequent *rabi* crop will show a definite increase in yield. Secondly, the presence of a leguminous crop on the field during the monsoon helps to prevent soil erosion. Thirdly, the cultivation given to the fields prior to the sowing of the legume, helps in getting the rain soaked into the soil. Even if the fields are embanked, as has been suggested in the discussion on conservation of water, a quick growing legume can still be raised for fodder on the lighter textured soils if the captured water from the embanked fields is run off at the right time. In soils of heavier texture, rice would be grown during the monsoon; and rice grows in standing water.

The cultivator usually applies farmyard manure to the fields being prepared for a *rabi* crop, well before the commencement of the rains and as early as May. This is a wasteful practice because the manure heaps are thereby exposed to hot winds and much of their value is lost. The best time to apply manure to *kharif* crops is a little before the first shower of rain.

The seed of the *rabi* crop is generally scattered or sown behind the plough. The use of a seed-drill in order to make inter-line culture possible would greatly improve yields; for, apart from nitrification being stimulated, weeds are killed and moisture is conserved by this method; and moisture is a limiting factor. Should there be no winter rain or very little, every bit of moisture that can be saved from evaporation helps to save the crop between flowering and ripening, from the devastating effect of the warm and dry winds.

For areas of moderate rainfall (between 15 and 35 inches), the sowing of a leguminous catch crop between June and October is often impracticable if a subsequent *rabi* crop is to be taken the same season. In such areas, it is generally best to embank the fields and get as much of the monsoon precipitation as is possible into the soil and subsoil, so that there may be adequate moisture for the *rabi* crop to follow.

In areas where the rainfall is below 15 inches, if the suggestions made to capture for the soil and subsoil the maximum amount of monsoon precipitation are followed, higher yields should result. Suitable rotations and mixtures, line sowing and inter-line culture are likely to give satisfactory results.

Manuring under such conditions must, however, be practised with the greatest caution and, if moisture and soil conditions permit, a light dressing of well rotted and finely divided compost applied either just before or just after the first shower of rain, would be beneficial.

The Seed Rate

Finally, research workers on dry farming have observed that *reducing the seed rate leads to increased crop production and saving in seed.* The reason for this is that, with fewer plants per square foot, the demands on the limited amount of soil moisture and fertility available under dry-farming conditions is less, and healthier plants are produced. With a crowded plant population there is not enough moisture or plant food to enable the majority of them to reach complete maturity. The seed shrivels and loses weight. With line sowing and inter-line culture, the chances of complete maturity are, of course, better; but even then the fewer the plants the better chance the majority of them have in producing fully developed and plump seed.

With cereal crops, tillering, or the throwing out of many sprouts from the same root, is an important factor contributing to higher yields. Tillering is discouraged by overcrowding and by the absence of inter-line cultivation. If ample space is available to the plant, and the soil around it is given light surface cultivation, the results in the presence of adequate moisture and plant food are most satisfactory, and considerably higher yields may be expected than from seed scattered haphazardly over the field.

Dr S. B. Singh has experimented in dibbling wheat seed by hand in Uttar Pradesh, and by this method the seed rate has been reduced from an average of 90 pounds per acre to 12 pounds per acre. Saving 78 pounds of seed per acre more than pays for the extra cost of dibbling by hand, and with line sowing and inter-line culture, tillering is stimulated to such an extent that normal yields are secured. If a suitable seed-drill was to be used, it would undoubtedly be an improvement on dibbling by hand, for during the sowing season there is a time limit within which the sowing must be finished. With hand dibbling, sowing over a large area cannot be completed in time, so this advantageous practice is

limited in its application. The need for evolving a suitable seed-drill for cereal crops is again emphasized.

Roadside Drains

From what has so far been said, it will be clear that there is considerable scope for further work on dry-farming problems; it will be equally clear that the knowledge we already possess should, if applied over the dry-farming tracts of India, greatly increase the production of our cereal food crops.

There is one more suggestion. Bishan Man Singh of Fatehpur, Uttar Pradesh, has shown that considerable advantage can be gained by utilizing waste rainwater from roadside drains during the early part of the monsoon. His method is very simple. His own fields are embanked, and the water he captures is charged with the droppings of animals and with other organic matter. Other farmers who have their fields by the side of main highways would do well to emulate his example because not only will their fields, if previously embanked, be enriched by the organic matter which the water brings, but the soil moisture will be greatly increased. The embankments can always be cut to let out surplus water after the solids carried by the water have settled down.

Wind-breaks

So far in this discussion, the emphasis has been on direct methods of improving production in dry farming. There is also the indirect approach. For instance, the planting of trees as wind-breaks goes a long way towards reducing evaporation in fields that are to the leeward. Breaking the force of the wind in hot and dry weather also saves particles of surface soil being blown about. Such trees as the *babool*, an acacia, and the mesquite are resistant to drought and the effect of their shade on growing crops is negligible: they are therefore especially useful in preventing soil erosion and evaporation. It is estimated that India is short of 20,000 million trees. If every cultivator were to plant 20 trees each year, half this number would be reached in about ten years, and the other half could be planted by the Forest and other departments of the Government. (Another job for a Land

Army.) Incidentally, trees bring rainfall and around trees appear grazing grasses where nothing grew before. Nurseries for the young trees will be needed in every village, and the sylvicultural experts of each state could soon determine what trees will grow best and where. The co-operation of villagers through their panchayats will save the State heavy expenditure.

MULCHING

In the United States stubble mulching has been practised with remarkable success in areas of low rainfall, and consists of sub-surface cultivation, leaving the stubble on the surface. It has been found by experiment that raindrops on bare soil destroy the surface structure and leave a thin compacted layer of soil through which water does not pass readily but runs off. Various sub-surface tillers, drawn by tractors, leave the dead residue of the previous crop on top of the soil, while under the surface the soil is loosened. The rain thus gets absorbed fairly completely, and the dangers of evaporation and run-off are minimized.

In India the implement rather like a blade harrow, already referred to as the *bukhar*, is the nearest equivalent of modern sub-surface tillers. But research has yet to discover what form of mulching, after harvest, is the best under Indian conditions, and what implements should be used. Rainwater enters soil through the spaces between the soil granules, and so long as these pores remain open, it will soak into the soil. Rain falling on bare soil tends to clog up the surface, but the presence of stubble in or on the surface soil prevents this and helps the water to be absorbed in the soil and subsoil. This is an argument against the bare fallows so commonly practised in India either because the cultivator knows no better or his bullocks are engaged in threshing after harvest and cannot be spared. The methods suggested elsewhere in this discussion for releasing bullock-power for this all-important work are therefore worthy of urgent attention.

The Chinese realized the value of mulching long ago, and have used a pebble mulch on their dry lands for many years. These pebbles allow the water to pass down through the mulch and trickle into the soil. They also reduce

evaporation by shading the soil, and restrict the amount of soil carried away by water or wind erosion. In Hawaii paper mulches have been used to reduce erosion, run-off and evaporation: There is, therefore, much to be learnt from the experience of other countries. We have to make the best use of whatever knowledge is already available by applying it in practice over as wide an area as possible in order that that our dry-farming lands may begin as soon as possible to provide us with higher yields of cereal and other crops.

CHAPTER EIGHT

HOW TO CONSERVE OUR WATER RESOURCES

THE annual rainfall of India varies from a mere 6 inches in some of the driest tracts to 600 inches in the Cherapunji hills of Assam. Even in the great Gangetic Plain, stretching from East Punjab to Bengal, the variation is considerable. The dry-farming areas of the East Punjab depend on a scanty 10 to 15 inches of rain, while the wet rice tracts of East Bihar, Orissa and Bengal mostly get over 40 inches in the year. The hills on the eastern borders of this plain get 50 to 100 inches annually. On the South and to the West of the peninsula, precipitation is heavy on and near the ghats (or hills), but is mostly inadequate elsewhere. This inadequacy becomes more pronounced on the great stretches of desert and semi-desert in Rajasthan and other states to the West of the Gangetic Plain.

Were this rain to be spread evenly over each month of the year, there would be little or no need for irrigation, except in the driest tracts. But to our misfortune, it comes down heavily during the three monsoon months of July, August and September and then, for several months on end, there is not a drop of rain. Conserving our water resources in the most scientific manner becomes, therefore, a matter of paramount necessity. The effect of gentle rain spread fairly evenly over the twelve months of each year is best seen in England and Ireland, where irrigation is not needed and where the countryside has an ever-green appearance. And yet the annual rainfall of Kent in England is only about 28 inches, a good deal less than the average for the fertile alluvial plains of Bihar which present a parched appearance during the dry months of January to June.

It has been estimated that the total quantity of water received by India from the clouds annually averages about 2700 million acre feet. This vast volume of water would

normally be sufficient to meet all the needs of any country the size of India. But such are the peculiar problems of this sub-continent and such is the character of the rainfall, that so far we have been able to utilize for irrigation through canals, tube wells, masonry wells, streams, tanks and *bandhs* only some 86 million acre feet annually. Even if, according to one estimate, all our proposed schemes, major and minor, of irrigation materialized, a further 100 million acre feet only could be utilized. There is therefore considerable scope for conserving all available precipitation from the clouds for utilization in the raising of our crops, especially of foodgrains.

We have seen, in earlier discussions, how freely erosion takes place when water flows, uncontrolledly, down sloping terrain. We have observed how the simple expedient of making low earth barriers to hold both soil and water, saves this land from sheet erosion. *Daulbandhi*, as it is called in North-west India, has proved to be an inexpensive method of holding up both soil and water during the wet months, and several other methods of checking soil erosion have been described in chapter three. It so happens that these measures are identical with those needed to conserve rainwater. Take, for instance, the ingenious method employed in the U.S.A. of running rainwater over a series of bench terraces. The absorption is so complete, that by the time the storm-water reaches the lowest terrace, it is practically all used up. The only method of conserving water which is not also a method of preventing soil erosion is the construction of dams in order to create lakes from which the water is led through canals for many miles to irrigate farm crops. But even this method is also a certain check to erosion, as the movement of water is slowed up by the *bandh* or dam. Some water, too, is saved for underground supplies, as it soaks through the bed of the lake and along the route it takes in order to reach the fields to be irrigated. And again, irrigation helps to raise the level of the subsoil water table.

The rain being received almost entirely during 3 or 4 months and the rest of the year being dry, two very definite problems are created. In the first place an enormous amount of water fills our rivers and is lost in the sea; and secondly, very little of the precipitation actually finds its way into

subterranean stores. One estimate[1] places the loss of rainwater at about half the total precipitation received during the year, only a fraction, about 3 per cent, being used at present for artificially irrigating crops. If it were physically possible to store up and use even a third of the water that gets away to the sea, it would provide enough irrigation to cover the entire cultivated area of India. To harness and utilize for artificial irrigation so large a volume of water is, however, physically impossible, even if the money to carry out so fantastic a scheme were forthcoming. Our experts on irrigation consider that the greatest area than can be artificially irrigated is 75 million acres as against 48 million acres irrigated today. But even this would take a very long time to achieve and would cost a lot more than the country can at present afford.

Let us therefore consider what alternative approach to the problem might possibly yield early dividends, bearing in mind the country's limited financial resources. That there is such an approach to the problem will possibly become clear to the reader of what follows. We must confine our attention to the dry tracts where the subsoil water level, as indicated by masonry wells, is over 30 feet below the surface of the earth in the dry period preceding the rainy season. We will not consider other tracts for the present, for reasons which will be evident as we proceed.

The Earth's Crust

The crust of the Earth is porous over millions of square miles. Consider the first 500 feet of this crust over the area stretching from the Himalayan mountains in the north to the peninsular plains of the northern part of the Indian subcontinent. In places the surface is rocky and non-absorbent; in others there is only a few feet of absorbent soil and below that, clay or rock; but over a large part of this vast area rain is absorbed to considerable depths without hindrance. It is this last type of surface with which we are chiefly concerned. It is here that vast underground stores of water collect, water which can be drawn to the surface for irrigation. The

[1] A paper by the Food Minister, read at an Extension Seminar, Indian Agricultural Research Institute, New Delhi, on 27 September 1951.

first 500 feet only of this crust are considered, because to bore a hole and send down tubes and strainers below that depth usually becomes uneconomical. The usual depths to which tube-well borings are taken are from 150 to 400 feet.

Consider for a moment what a cross-section of this 500-foot layer of the Earth's crust consists of. First of all, there is the soil. Then there are some 20, 50 or 100 feet of a mixture of sand, clay, gravel and broken rock, and through this mixture water can find its way although, at varying depths, layers of impervious clay intercept its downward movement. This clay is met at depths of 20 to 50 feet in the Gangetic alluvium and at greater depths in the sandy plains of Rajasthan. In tracts such as those of Bundhelkhand and Central India, solid rock intercepts this downward movement of water and those who make wells for irrigation have to blast it. The first 20, 50 or 100 feet resting on clay become charged with rainwater at the lower depths. It is on this clay that makers of masonry wells rest the foundations of their wells, and the water is drawn up by various water-lifting devices.

Below the first clay layer there are, however, other such clay layers alternating between more layers of coarse or fine sand, gravel and broken rock. This is of importance to farming because all the way down to a depth of 400 feet or more there are found strata of coarse sand or gravel in which has accumulated water, supported in turn by the clay underneath. Some of this water has travelled sideways hundred of miles underground and some has come from the surface not so far away and has found its way to greater depths through breaks in the various impervious layers. The fact that rainfall is heavier on our hills than in the plains, combined with the greater height at which the water begins its long underground journey, is important. On this depends the success of tube wells; for water must find its level. The water having entered the earth higher up, the tube sent down through the clayey layers soon gets filled with it, under pressure. The pressure is usually enough to bring the water up to within a convenient distance of the surface. Occasionally, it is enough to create artesian supplies.

It is thus clear that over the dry tracts of India, where the water-table stands some 30 feet or more below the surface

Lifting water from a tank for irrigation, by the ancient *beri* or swing basket ; a strenuous method, very trying in hot weather.

A modern Persian Wheel of improved design. Frictional losses are reduced by the proximity of the driving gear to the bucket wheel. The machine is a compact unit fixed on iron girders and has other commendable points.

and where irrigation water is very definitely in short supply, every possible means of conserving rainwater must be adopted. The water-table, which is the level at which percolation water rests on the first impervious layer of clay in the upper crust, has to be raised. For only in this way is it possible to extend irrigation from masonry wells. This is the first problem and the solution of it is as simple and inexpensive as that already suggested for the prevention of soil erosion: it is, to conserve water.

DAULBANDHI AGAIN

We have seen how the simple expedient of *daulbandhi* helps to prevent sheet erosion. This consists of a low barrier of beaten earth, about 18 inches high and as wide at the base, put up on at least three sides of each field. The fourth side need not be closed, although it often is. This in itself helps to hold up rainwater and let it soak in slowly; but to get better results these barriers should be a little taller, say 24 inches high and as wide at the base. Much will depend on whether the soil is sandy or clayey in texture, and the height of the barrier is best determined on the spot.

It is difficult to say how much rainwater will actually soak into the soil and find its way to the first clay bed, and how much will be lost by evaporation. All that can be said is that by this simple method considerably more water will find its way into the bowels of the upper crust than would otherwise be the case. Evaporation is a more or less constant factor, whether the water stands a foot deep or a fraction of an inch on the surface of the field. What we are more concerned with is percolation, and we are certain that it is increased appreciably by capturing rainwater in the manner suggested. The labour needed to put up these earth barriers is available and can be utilized in the slack season preceding the monsoon. The Indian farmer is accustomed to digging by hand: He will have to be shown the value of embanking his fields by demonstration.

Increasing the subsoil moisture in this manner has more than one beneficial effect. In the first place, such post-monsoon crops as wheat, barley and gram, grown without irrigation, will show better germination and healthier growth. The preparation of the seed-bed by cultivation

after the monsoon, will result in greater nitrification and other bacterial activity by virtue of the presence of adequate moisture. Early sowings, whereby ultimate yields are improved, will then be possible. The standing water, incidentally, will tend to eliminate the rapid growth of weeds and this will result in a better crop freed from competition for moisture and plant food.

In areas of comparatively low rainfall, embanking fields and letting canal water stand in them during August and September has been proved, by C. H. Parr's experiments, to increase the yields of winter cereal crops very considerably. At this time of the year rivers are full, especially in North-west India, and canals can provide all the water needed for the flooding of fields intended for winter cereals. This has no ill effects on the subsoil water-table; for in areas of low rainfall, 15 to 25 inches, the water-table is also low. Raising it is definitely beneficial, and there is no danger of its coming too far up by this one flooding.

At first, while the practice is still new to many villages, embanking will present occasional problems. For instance, after a night of heavy rain there may be breaches to repair, and for this the owners of the fields will have to be watchful, as a small breach repaired in time will save a lot of labour later. The embanked field will not be available for the sowing of any monsoon crop other than paddy: On fields where fodder or a legume is grown, the owner will, therefore, have to create a breach in the barrier to allow the surplus water to run out of the field. Sometimes it may be found that a clayey subsoil prevents the rainwater being absorbed to any great depth. Generally, however, it will be found that bunding or embanking helps absorption to take place to considerable depths, with evident value to the farmer, and this has already been realized in the Haveli tract of North Madhya Pradesh and in places on the black cotton soils of Central India and the Deccan. What is wanted is that the practice should be adopted wherever soil, subsoil and moisture conditions make it desirable.

AFFORESTATION AND TERRACING

So far we have discussed a possible way of increasing subsoil water supplies to the first clayey underground

barrier—some 40 feet to 100 feet or so below the surface. What of the water-bearing strata below spring-water level? How are the underground stores of water which feed our tube wells at depths ranging from 150 to 500 feet to be augmented? The answer to this will perhaps have occurred to the reader already. Starting with our hilly areas, where the rainfall is as a rule the heaviest, a good deal of land has in the past been cleared of trees for farm crops. These lands are exposed to erosion by storm-water, and both soil and water will be wasted unless terraces and dams are so constructed that only the minimum of wastage takes place. Scientific bench terracing will achieve this; and if in addition trees are planted on all waste land not so terraced, losses will be kept down permanently. Grasses planted on the terrace walls and trees or shrubs on field borders will help to hold both soil and water.

Effective conservation of soil and water should form a compulsory part of the training of all Forest, Agricultural and Revenue officials of the State. All our hill men must be told about soil and water conservation until their entire outlook to the problem is transformed from one of careless indifference to active co-operation with the State in all the measures it adopts. Then only will we have begun to find the answer, not only to short supplies of underground water, but to the problem of silt in our river beds, of floods and of hillside erosion.

Broad-based terraces, bunding, prevention of over-grazing, afforestation of waste land and other measures discussed in chapters three and six, will all help to conserve rainfall, now and in the future. The immediate effect, visible on the surface, will be higher yields and these will be due to the increase in the amount of moisture held by soil and subsoil. C. H. Parr's experiments have proved conclusively that embanking fields in dry areas and running river water into them during the latter part of the monsoon, increases the yield of wheat and other crops. This water would otherwise have been wasted, since during August and September canals are usually emptied for de-silting and repairs. There is however time to do this after water has been run into the embanked fields.

As for lakes and tanks, there will always be enough run-off water during the monsoon to replenish them, for

it is not possible to conserve more than a fraction of the vast volume of water received from the clouds. Conservation practices will help to replenish those underground springs which feed so many of our lakes and streams which are used for irrigation of farm land. Trees and shrubs will flourish and grasses will spring up in places where cultivation is not feasible and will provide much needed grazing.

Perennial or seasonal irrigation by our great canal systems will not be discussed here, for they are already in expert hands and many ways of making a little water go a long way are already being tried. What are not in expert hands, and consequently need examination, are the ways in which the improved underground water supplies can be put to the best use; for one fact must be fully appreciated and that is that a regular supply of water on cultivated fields enables the farmer to use more manure than he does at present; the two factors combined having the effect of increasing crop yields—always the desideratum.

Having, therefore, considered ways of conserving water for soil, subsoil and nature's underground reservoirs, the next step is to examine the means whereby the additional supplies can be utilized for irrigation.

Simple Water-lifting Devices

The most primitive and yet the most commonly used water-lifting device, the *beri* or swing basket, is operated by four men working in relays of two, and can lift water a maximum height of about 4½ feet, usually from tanks. Less common, but still fairly frequent, is the use of two or more swing baskets which, working as a team, will lift water another 6 or 7 feet, i.e. to 10½ or 11½ feet in all. Both processes are expensive in labour and meagre in result. The amount of water lifted varies with the height of the field above the tank surface, but is seldom more than 1500 gallons per hour. The *dhekul* or earthen pot, attached by a rope to the end of a pole, weighted at the opposite end and operated by a single person, is another common device. This is used to lift water from streams and other sources to a height of some 7 to 12 feet. Here again the quantity lifted is small, seldom exceeding 800 gallons per hour. Then there is the *mhoth* or *charas*, a large leather bag drawn up by bullocks

moving down an incline, the rope moving over a wooden pulley on wooden supports. This is used mostly with masonry wells and is a common sight over most of the dry plains. It is often used with wells 70 or more feet from the surface; the discharge varying with the height of lift. It is not an efficient device, although it will draw water from deep and narrow wells where no other cheaply constructed water-lift will. The Indian cultivator today uses these four ancient water-lifting devices more commonly than any other, because they are cheap and wood is not in limited supply as are iron and steel. The use of modern water-lifting devices is, however, gradually displacing the old wasteful methods.

The Persian Wheel

A decided improvement on these ancient water-lifts is the Persian Wheel of up-to-date design. These machines, especially some of the improved patterns, can be made to suit wells of any diameter. One recent design, at least, can be operated either by electricity or by an oil-engine with the help of a reducing gear. The parts of this model can be standardized and produced on a mass scale, bringing the cost of production down very considerably. Even if worked by bullocks, an improved Persian Wheel will give twice to three times the discharge of a *charas*. The most enterprising farmers of India are today using Persian Wheels more than any other modern device, because these machines will usually lift as much water as is required, and they are less expensive than pumping plants worked by electricity or oil-engines. Unfortunately there are far too many Persian Wheels in the market cheaply made from inferior material and giving only inefficient service. To see that only the most efficient and well made Persian Wheel is put on the market should be the duty of the State, and where individuals cannot afford these machines, loans should be forthcoming in kind rather than in cash. Where co-operative unions of growers exist, they should be able to acquire for co-operative use, several of the best machines. The State must see to it that the necessary iron and steel is made available to approved manufacturers and that adequate servicing and spare parts are forthcoming. Let the State hold official tests to determine which type of Persian Wheel is the best,

and thereafter see that its makers receive all necessary aid, so that as many of these superior machines as possible are placed within the easy reach of even the most remotely placed grower. The relative advantage of the mechanically driven centrifugal pump over the swing basket for a 7-foot lift, is so great that it cannot be ignored, especially as the yield of the irrigated cereal crop is likely to increase from 6 to 10 times with the use of the former. But while the pumping set, whether driven by electricity or by oil-engine, is usually too expensive for the farmer of 10 acres or so, the Persian Wheel costing Rs 450 is well within his means.

It is up to the State to initiate schemes for utilizing to the full the underground water supplies of the country, and for irrigating from streams, tanks and lakes: It must then follow them up by arranging that the farmers concerned get adequate supplies of the most suitable water-lifts at a reasonable cost. The periodic servicing of these machines and the maintained supply of spare parts are other facilities which will have to be assured. With so many experienced migrant artisans from the West Punjab, this should not present any serious difficulty, but the state government concerned must, with the help of these artisans, organize the necessary servicing agencies. Then only will any large-scale use of improved Persian Wheels, pumping sets and the like, yield the dividends that are to be expected from really efficient water-lifting appliances, i.e. increased acreage under irrigation, higher yields for the grower and more food for the nation.

The Financial Aspect

There is, however, one aspect of planning minor irrigation which must be tackled wisely if India's food production is to be raised to the desired level economically. In the Five Year Plan, minor irrigation schemes are expected to yield 2 million tons of additional food at a cost of Rs 119·45 crores (about £85 million). The cost of desilting tanks and repairing water channels, *bandhs*, wells and pumping installations are included in this sum. Cleaning tanks is a profitable occupation because (a) more water is made available for irrigation and (b) the silt removed has a beneficial effect on cultivated fields. Repairing water channels is profitable because the grower is able to secure more water for his

fields. Removing the silt has obvious advantages. The grower, in fact, benefits all round; why then should the scheme be charged up to the taxpayer? The cost per ton of additional food produced, under the tanks and channels scheme, works out at about Rs 7 per maund or Rs 9 per hundredweight. This is high; but when it is considered that the value of the extra food produced more than covers the expenses of desilting and repairs, why should the taxpayer rather than the grower, have to bear the burden? The grower is the first to benefit from the scheme; there is little or no financial outlay involved, and he should not grudge the labour. If, indeed, the State had to employ labour and pay for it the cost would run into millions, and the burden of taxation is high enough already: Why add to it when those who benefit can do the work? If the states concerned could find ways of achieving the desired results in schemes of this nature by the use of wise legislation and with the minimum of financial aid, it would be conducive to securing a larger measure of success than that the Five Year Plan visualizes, and at smaller cost. For example, the construction of *bandhis*, embankments with brick and cement outlets, large or small, which hold enough water to make them useful for irrigation, needs financial aid. These minor works do, however, benefit a number of growers, and it should be possible to get the earthwork involved done by them.

Be all this as it may, the main object is to make the maximum use of rain for irrigation purposes, whether from *bandhis*, tanks or wells, and it is for the Central Government to take the initiative in completing, first without and then, if necessary, with the use of legislative or executive powers, the maximum number of effective minor irrigation schemes, through the various states, at the minimum expense. At the moment, the states submitting such schemes have to undertake to bear half the cost, the other half being borne by the Centre. Part of the state cost is advanced as a loan by the Centre. Considering the advantages accruing to the growers who share the benefits from these schemes, it seems illogical that the Centre should be called upon to bear so much of the cost and that anything more than a loan should be necessary to induce states to come forward with these schemes. The possibility that private enterprise may be

interested in the matter has not perhaps been fully explored. A Land Development Corporation, whose function is explained in later pages, might also be able to take up such schemes over a part of the country.

Water-logging and Excessive Moisture Accumulation

We have so far discussed water conservation in dry tracts. It would be well to consider also for a moment the problem of excessive water, which has become an alarming one in parts of the country. The measures necessary to deal with it are the very opposite of those required to conserve rainwater for drought-affected areas. There are two main features: firstly, water-logging due to many decades of canal irrigation; and secondly, excessive accumulations of water due to faulty drainage.

Constant irrigation in vast areas where the underground water-table was already fairly high, has brought the water level so near the surface, that the evils of soil acidity, efflorescence of alkaline and saline salts, and marshy conditions have actually put out of cultivation much land which was originally productive. Some of these problems have already been discussed in an earlier chapter. One of the remedies is to pump out the subsoil water, throwing it back into the canal which will take it away to distant areas, not so affected. Another step, which a courageous administration might take with advantage, is to close down the canals in these areas for several years, encouraging at the same time the construction of a vast network of wells fitted with water-lifting devices. The subsoil water lifted from the wells would be used for irrigation; but so much more would be lost by evaporation than used by the crops that the ultimate effect would be the much desired one of lowering the water-table. Hydro-electric power is extending over many parts of the country: would it not be possible to utilize some of it in pumping up water from the network of wells for this purpose? The matter is one for consideration. By the use of one or other of these remedial measures, it might be possible with the help of a Land Development Corporation to bring about healthy soil conditions over very large areas now affected by these harmful accumulations.

The other type of harmful water accumulation—both are due to a short-sighted Public Works Organization—is one which was discussed by the United Provinces Agricultural Reorganization Committee in their Report of 1938-9. Failure to provide an adequate number of outlets for monsoon storm-water along railway embankments and the main highways throughout the country, has been responsible for considerable harm to good agricultural land on either side. It is not too late to take this problem in hand. Apart from making drainage outlets, much of this water could perhaps be led into natural depressions and utilized as fisheries or led away to irrigate the dry land bordering on these wet areas. Rooting out the evils which have resulted from a faulty water economy is, anyway, the primary objective.

The Fundamental Law

To return to those vast dry areas which are in urgent need of all possible measures to conserve rainwater, should there be several successively weak monsoons, there will be a tendency for wells, tanks and streams to run dry or almost dry. The storehouse of underground water is rather like a huge bank. If the money taken out is not replaced by adequate deposits, then the bank, no matter how large, must ultimately fail. The same applies to the whole of Nature. Cut down forests without replacing them and the land which supports us will soon be laid waste by floods and erosion. Allow erosion to continue unchecked and not only soil, but surface moisture, will disappear. The ancient civilizations of Egypt, Carthage and Babylon were destroyed because of Man's wastefulness in not replacing what he took out from the soil. Even if Man in the past did not understand the fundamental and natural law of supply and demand, there is no reason why he should remain ignorant in these modern times. If, because he once had an abundance of natural wealth in forests and agricultural land, he was careless and indifferent to wanton waste, there is no reason whatsoever why he should not endeavour to make up for the mistakes of his ancient forbears now. India's national economy just cannot bear the terrible burden of natural wealth being wasted any longer, be it soil, organic residue, or precious rain.

CHAPTER NINE

FERTILIZERS AND INTENSIVE FARMING

THE term 'intensive farming' means, under Indian conditions, the almost continuous raising of crops with the help of heavy manuring and irrigation. The land gets little rest; and it follows that only where ample irrigation is available can intensive farming be practiced. Only the 48 million acres under irrigation and those areas intended for irrigation under the Five Year Plan and other projects, will therefore be considered here.

CAPABILITIES

The per acre yield of crops raised under irrigation, heavy manuring and fertilizing is generally 50 to 100 per cent higher than that raised under dry farming, and since it is possible to get yields as much as 200 to 400 per cent higher by scientific methods, the subject becomes of special interest. The irrigated area under wheat alone is some $7\frac{1}{2}$ million acres and the present average yield under irrigated conditions of about 1,200 lb., is capable of being raised to an average of 2,400 lb., and in exceptional cases to 4,000 lb., per acre. Supposing that, over these $7\frac{1}{2}$ million acres, it was possible within 3 or 4 years to raise the present average yield by even 1,200 lb. per acre, 4 million tons more wheat would be available. This would not only make the country self-sufficient in wheat at the present rate of consumption, but would leave a surplus for export. The output of irrigated rice, at present covering an area of about 21 million acres, could in the same way be increased to meet the country's entire deficit, and leave a considerable export surplus. Let us examine, therefore, how these very desirable results might be achieved without straining too much the State's financial resources.

A few years ago the Government of India instituted a system of awarding prizes for the highest yields secured

for wheat, rice, potatoes and sugarcane. Here are some of the results achieved in 1952:

	Highest per acre yields secured (maunds)	(lb.)	Place	Average all-India yields (lb.)
Wheat	71·5	5,863 (over $2\frac{1}{2}$ tons)	Ludhiana (Punjab)	554 (includes both irrigated and dry wheat)
Rice	136	11,152 (about 5 tons)	Coorg	628 (includes both irrigated and dry rice)
Potatoes	733·5	60,147 (about 27 tons)	Bulundshahr (U.P.)	6,184 (irrigated)
Gram	46	3,772 (about $1\frac{3}{4}$ tons)	Ludhiana (Punjab)	421·5 (dry)
Juar (sorgham)	84·5	6,925 (about 3 tons)	Kolhapur (Bombay)	321 (dry)
Bajra (a small millet)	29·25	2,398·5 (over a ton)	West Khandesh (Bombay)	220·5 (dry)

These exceedingly good results, secured under the incentive of a prize of Rs 5,000 or, alternatively, a light tractor for each of the six winners, prove that (a) the Indian farmer is capable of producing yields comparable with the highest obtained anywhere in the world and that (b) Indian soils respond magnificently to heavy doses of fertilizer and bulky manure; for it was not by magic that these results were obtained. It is not intended to suggest however that it is possible to secure such yields in every area where these crops are grown: But the fact of having secured them locally points to the possibility of doubling or trebling the present average by means of intensive farming, but without undue strain on the country's resources.

The State's Responsibility

There are, however, many factors which at present militate against securing this very desirable result. Not every farmer has either the ability or the means to invest enough capital and effort in his land to double his present yields. Secondly it is doubtful if enough bulky manure and commercial fertilizer will be available for some years for the entire area under food crops. There is no reason, however, why an effort should not be made to get as many farmers as are likely to provide the necessary interest and enterprise, to emulate in some degree the example of those who have won prizes for the unusually high yields secured in recent competitions. The State will have to comb the intensive-farming tracts for such farmers, to make a list of them and to provide them not only with skilled advice, but with facilities such as transport and loans to enable them to secure the necessary manures and fertilizers. This should not present insuperable difficulties.

In chapter three some indication has been given of how the supply of bulky manures can be increased. The Sindri factory is now turning out fairly large quantities of sulphate of ammonia and there are indications that India's production of bonemeal is rising. That takes care in part of two essential fertilizing elements, nitrogen and phosphates; there remains potash. Fortunately, potash is not generally deficient in Indian soils. A systematic drive to conserve all ashes of wood and leaves throughout the length and breadth of the country would make available quite a considerable amount of potash that is at present wasted. This could always be supplemented by imported potassic fertilizers, which together with some imported superphosphate would be the only charge on the State's limited dollar and sterling exchange resources.

Stocks of these imported fertilizers as well as the indigenous sulphate of ammonia should be made available to the officials or experts entrusted with the task of guiding the farmers selected. There should be no shortage of any one of the three main chemical fertilizers, nitrogenous, phosphatic and potassic, to farmers for whom irrigation facilities are available. Calculations made in advance of the optimum doses and of the best manuring period should determine the

quota for each compact area selected for intensive farming in wheat and rice. There should be no delay in the arrival at the time specified by the expert in charge of each block, of each fertilizer required. Side by side with arrangements for securing chemical fertilizers, stocks of such bulky manures as cattle-dung, village and town compost must be built up. The State must assist in transport by trucks or tractor-driven trailers, the charges for such transport being treated as loans to the farmers, recoverable at harvest. In some cases it may be necessary or desirable to treat the cost of the bulky manure and of the fertilizer as a loan. The high yields obtained as a result of the heavy doses of manure and commercial fertilizer should take care of all the farmer's debts of this nature.

The next care of the State should be to ensure that there is no shortage of water for irrigation, either in volume or in the frequency of its application to the crops under treatment. Timely irrigation is as important as the total volume of water applied, if not more so. A breakdown in the supply of electric power for tube-well irrigation; a disruption of the normal roster arrangements for canal irrigation, or a defect in the engine or motor owned by the farmer, might upset the whole or part of the scheme, especially if it should come at a time when the need for irrigation is critical. The success of the plan will therefore depend as much on careful planning, foresight and wisdom on the part of the officials responsible as on the willing co-operation of all others concerned, official and non-official.

CULTIVATION

A word concerning cultivation. In intensive farming, when rest for the land is limited and often insufficient, it is most essential that, between the harvest of one crop and the sowing of the next, very thorough cultivation be given to the soil, incorporating heavy dressings of bulky manure and commercial fertilizer. The object of applying manure to the field is not achieved if it is put at a depth at which the main roots of the crop concerned do not normally feed. For cereal crops therefore, manure must be applied and incorporated into the soil at a depth of 3 to 7 inches. Ploughing or discing must be 5 to 7 inches deep, depending on the class of soil,

for the best results. Modern bullock-drawn ploughs can reach this depth and should be followed by a cultivator stirring the soil 4 to 5 inches in depth. It is not necessary or desirable to bury bulky manure by using a soil-inverting plough. The value of the soil-inverting plough lies more in exposing the lower layers of the soil to sun and air than in turning down muck or manure on the surface in order to completely bury it. The Faulkener school in the United States has no use at all for soil-inverting ploughs, and there they advocate the use of disc cultivators, treaders and other such implements, to chop up and incorporate whatever green or dry organic matter there may be present, into the top 3 or 4 inches of surface soil. All scientific farmers are not, however, in agreement with Faulkener in the theory he has propounded in his book *Plowman's Folly*[1] although some are practising the methods of cultivation he recommends; for in certain conditions of soil and climate the Faulkener system has its points.

The Supply of Implements

The farmers selected to implement the plan of doubling or trebling the cereal crop yield will not only need guidance and advice on the quantity and quality of cultivation to give to their fields, but will also, in a large number of cases, require assistance in securing supplies of the right kind of implement for the job. Where tractors can be requisitioned by the State—and these are generally supplied with the necessary implements of tillage—they should be concentrated in the areas or blocks selected for the plan. The fields selected for intensive cereal production must be given priority in the use of these tractors, the cultivation charges being recovered from the farmer when his crop has been sold.

Where tractors are not available, the State will have to stock suitable ploughs, disc harrows and other types of bullock-drawn implements of tillage in sufficient numbers and conveniently near the blocks selected. The farmer should be able to get these implements at reasonable prices and if possible under a system of co-operative purchase, and they must not be allowed to drain his limited financial

[1] Grosset & Dunlap, New York, 1943.

resources. Payment by instalment and in convenient stages should be arranged in such a way that he does not feel he has to bear a heavy burden. Spare parts must be stocked in sufficient number, and for each type of implement efficient servicing should be provided, so that at no stage will the farmer be embarrassed by stoppages in preparing seed-beds, in subsequent inter-line cultivation or in harvesting and threshing his crop.

In regard to harvesting, wherever tractor-power is available the operation should preferably be done mechanically. With heavy crops to harvest, labour difficulties are bound to arise and the sooner the harvest is over the better; for in intensive farming the field should be cultivated lightly as soon as the crop is lifted in order to prevent undue loss of moisture and to secure the beneficial effects of aeration without undue delay. Bullock-drawn harvesting machines have not yet become popular for a variety of reasons, chief among them being the absence of adequate servicing facilities and spare parts. With the higher yields secured in the plan under discussion, these machines will be in a demand which it would be well to anticipate.

Threshing a cereal crop like rice does not present any great problem and will not, even if the present average yield per acre is doubled or trebled; but the threshing of wheat is quite another matter and a sufficient number of threshing machines worked by tractor or other power (including the bullock-drawn Olpad thresher) will have to be made available. Failing adequate arrangements, the farmers in the blocks selected will have considerable difficulty in completing the threshing of their wheat before the advent of the monsoon. Bullock-power by itself is not enough because treading the sheaves takes too long, especially if mechanically operated winnowers are not available in sufficient numbers for the final separation of grain from chaff before bagging. But augmented by the caterpillar type of tractor described in the next chapter, there is adequate bullock-power available in intensively farmed areas for the Olpad or other improved disc threshers to be used with advantage. The final work of threshing and winnowing heavy crops will nevertheless have to be very carefully thought out.

Growing Paddy

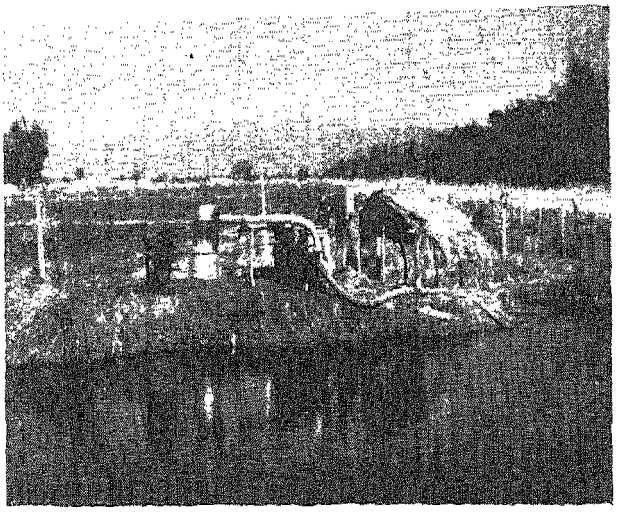
The Japanese method of growing paddy, whereby high yields are obtained, has been discussed so much of late that it is desirable here to describe it only briefly. There is very little to be learnt by the best Indian farmer from this or any other method. It is doubtful if, even in Japan, as much as 11,152 lb. per acre of this crop has ever been harvested by this method; yet this is the yield secured by our prize-winner in the Indian crop competitions of 1952. What the Japanese method has done is to systematize or reduce to a universally applicable mode of operation a procedure practised in varying degree by our best paddy growers for many years.

In the nursery the seed-bed is raised some three inches above ground level and may be of any convenient length. A space, a foot wide, is left between beds. This permits of weeding without injuring the seedlings. For each acre of paddy 1/20th of an acre is sown in the nursery for seedlings, and this requires about 20 lb. of seed. For each 25 feet of bed, about a maund (3 baskets) of compost or cowdung is worked into the soil. To this is added a pound of equal parts of superphosphate and ammonium sulphate. The surface is smoothed and then covered with fine compost about 1/8th of an inch thick. This again is covered with a thin layer of ashes. The bed is then ready for the seed which is planted at 1 lb. to about every 25-foot row.

Before sowing, the seed of the variety most suited to local conditions is dropped into a bucket of salt water. The poor seed comes to the top and is skimmed off, saving only the heavier seed for sowing. The seed is sprinkled on the seed-beds a few days before the rains commence and the covering of fine earth 1/8th of an inch thick spread over the seed. Should the rains be delayed, watering by cans is resorted to. Where canal or tank irrigation is available, sowings commence earlier.

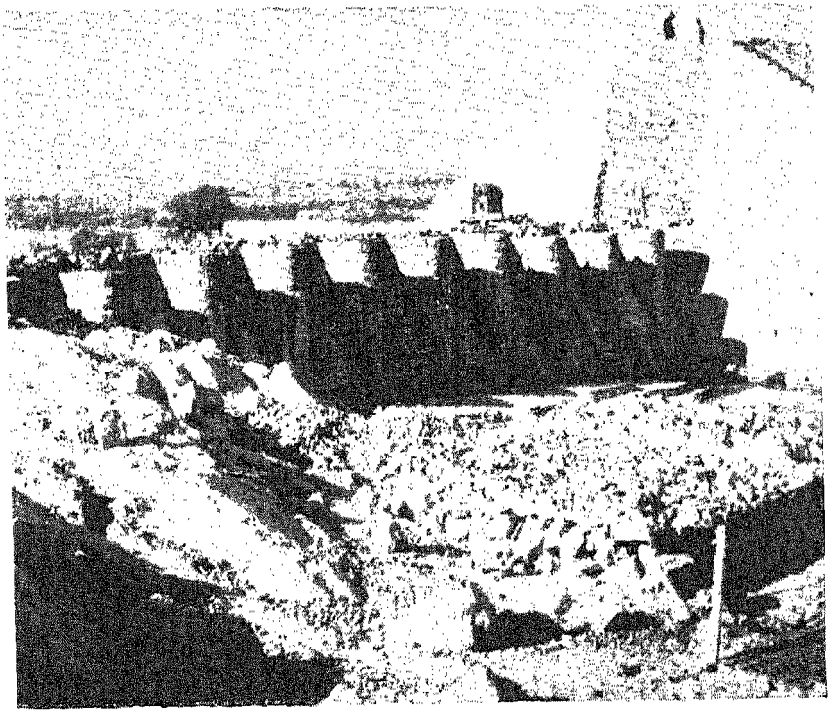
About a week after the seedlings have come up, all weeds are carefully removed by hand. The seedlings are ready to transplant when the sixth leaf has formed. The plant is 6 to 8 inches high at this time. It is better to be early than late with transplanting.

The field into which the seedlings are transplanted is ploughed immediately after harvest; then, following the



A mechanically driven centrifugal pump drawing water for irrigation from a stream.

The Saprar dam, Bundhelkhand. Although dams of this size provide irrigation for comparatively small areas, they are invaluable as aids to the improvement of rural conditions in such terrain.



first shower of rain, the field is ploughed again. All paddy fields being bunded or embanked, all cracks in the *bandhs* should be repaired before the rains. Manure is then applied in heavy doses. Green manure is advocated and 15 to 20 cartloads of compost or cattle-dung should be ploughed in before puddling. One hundred pounds each of ammonium sulphate and superphosphate (or bonemeal) is mixed well into the surface soil.

In the process of transplanting care is taken (a) to remove all weeds from the nursery before beginning, (b) to pull the seedlings out one at a time, and not to bruise the stems or break the roots, (c) never to plant more than 4 seedlings to each hole, (d) always to plant them straight rather than at a slant, (e) to hold the fingers of the hand along the side of the seedling, pushing them into the soil ahead of the roots of the seedling and (f) to plant the seedlings 10 inches apart and 10 inches from row to row.

To speed the process of transplanting, two workers hold a long string in a straight line. On the string are markers 10 inches apart. The seedlings are inserted in the soil at the markers; the string is then moved over 10 inches and planting at the markers is repeated. Bamboo may be used instead of string.

After the crop has grown for two weeks, all weeds are removed. A month after transplanting another dressing of 100 lb. each of ammonium sulphate and superphosphate is worked into the soil around the roots of the plants. From now on a soil-scratching tool is moved between the plants. About two weeks before flowering, all field work is stopped.

It will be seen that an important factor in securing high yields by this method is the liberal use of fertilizer, supplemented with bulky organic manures like compost and cowdung.

Fertilizer plus Bulky Manure

The value of commercial fertilizers, including oil-cake, is not unknown to the best of Indian farmers. Indeed, in the areas where such crops as potatoes, sugarcane, rice and wheat are grown intensively, the demand for commercial fertilizer far exceeds the supply. If they were only available in sufficiently large quantities and at reasonable prices—lower

than the present prices by say 15 per cent—consumption might quite possibly be doubled. With a further drop in price it would go up still further, demonstrating a trend which is known to anyone who has moved among farmers of the poorer class. The reason is that the farmer has tried heavy manuring with cattle-dung and other bulky manures and has found that by the addition of commercial fertilizer he is able to get considerably higher yields of cereals, root, sugarcane and other crops. With a crop like sugarcane, for instance, response to nitrogen applied as sulphate of ammonia is often as high as 370 lb. of crop per 1 lb. of nitrogen applied. This is also the experience of farmers in other parts of the world.

In a recent paper[1], R. I. Throckmorton, Dean of the Kansas State College of Agriculture and Applied Science, U.S.A., discusses most admirably the argument in favour of the use of commercial fertilizers along with that of bulky organic manures. He points out that organic matter 'supplies most of the food needs of the soil organisms which aid in changing non-available plant food materials into forms that are available to the plants'. Organic matter, in fact, contains practically all the plant food material, but in limited quantities. Supplied by bulky manures, it improves soil tilth and increases the water-holding capacity of the soil. It further acts as a storehouse for the reserve nitrogen supply, and when soil nitrogen is not combined with organic matter, it can be lost rapidly by leaching.

Most soil scientists are agreed that organic matter alone though most important does not provide all the soil fertility needed to produce adequate yields of food crops. Throckmorton states that 'muck soils' or soils rich in applied organic matter contain as much as 20 to 50 per cent organic matter. But they still need fertilizer for efficient production. This is fundamentally true under Indian conditions, and deserves serious attention.

Here are a few examples from the United States of the difference which fertilizers make when used in conjunction with organic matter or bulky manures: Wheat raised on soil containing 20 to 50 per cent of organic matter, but

[1] 'Organic Farming Bunk' (*Reader's Digest*, November 1952, taken from *Country Gentleman*).

without chemical fertilizer, yielded 5·7 bushels per acre, while the yield on plots treated with chemical phosphorus and potash was 29·2 bushels per acre. In other words the use of fertilizers in the presence of ample organic matter increased the yield by 400 per cent. Potato yield was increased by the same means from 97 bushels per acre to 697 bushels per acre, or an increase of nearly 600 per cent. In the case of cabbages the yield was raised, by the same means, from half a ton to 27 tons, an increase of 5400 per cent! These results are quoted by the Dean of the Kansas State College and must be taken as authentic. In the Middle West of America, fertility experiments on the grey silt loam soils, showed that over a 24-year period the average annual yield of lucerne, a valuable fodder crop now grown extensively in parts of India, was only 0·59 of a ton per acre, despite the use of large quantities of bulky organic manure. By adding lime and superphosphate, the same land produced an average yield of 2·29 tons, a 250 per cent increase.

Not only does the use of commercial fertilizers increase the quantity of food and fodder produced per acre; but the quality is also improved where the soil is deficient in the element applied as chemical fertilizer. For example, in the U.S.A. experiments have shown that the protein which is so important in building up living tissue, is increased in maize from a mere 5·7 per cent to 10·4 per cent by the use of nitrogenous chemical fertilizers. In India, where proteins are not generally plentiful in the vegetarian diet of the vast majority of the people, so substantial an increase in the protein content of an important food crop, is of special interest. The subject of improving in quality the staple food of the masses, is one of the utmost national importance and is one which deserves the attention of those responsible for initiating and conducting research work on the various aspects of the food problem. What has been achieved in America can certainly be achieved in India and it is most desirable that work on improving the quality of food crops be commenced as early as possible. Areas under intensive farming offer ample scope for a careful study of the effect of fertilizers on wheat, rice, maize and other food crops.

The use of fertilizer has produced other remarkable effects in the U.S.A. and in England. For example, it has been observed at the Kansas State College that green-fly—a pest to certain crops and particularly to wheat—is very numerous on fields where substantial quantities of bulky organic manure have been applied. On adjoining fields under nitrogenous and phosphatic fertilizer, very few of these insects were present. At the Rothamstead Experimental Station in Harpenden, England, earthworms—which help in maintaining soil fertility—are bigger and fatter in fields where fertilizers have been used, and are just as numerous as they are in fields where no fertilizer is present. Similarly, the application of superphosphate to the soil at rates commonly recommended has been observed to increase the population of beneficial soil bacteria. Finally it must be borne in mind that because the use of fertilizers in conjunction with bulky organic manures results in heavy crop yields, organic matter in the soil is increased through heavier root growth and more stubble being ploughed or worked into the soil after harvest. The additional organic matter promotes the growth both of bacteria and of earthworms, both of which are most useful to the farmer.

Non-cereal Crops

Under intensive-farming conditions, particularly in the vicinity of large markets, a good deal of attention is being given to the raising of vegetables and other subsidiary foods. The numerous tasty dishes that are being turned out by experts in the Annapurna drive to save cereals will encourage the greater use of green vegetables, fruit, potatoes and nuts, and already there are restaurants run by government and private agencies to supply foods prepared from non-cereal ingredients, in a number of towns. But even in the growing of vegetables, the attention paid to the use of fertilizers is appallingly meagre, and the demand for roots, cucurbits, legumes, greens and fruits of all kinds is growing; for the health and well-being of the masses depends on their consuming adequate quantities of these non-cereal foods. And unless production is increased, the present high prices of these foods will militate against their being consumed in adequate quantities. Examples have been quoted from the

United States where the production of potatoes and cabbages has been increased by 600 and 5400 per cent respectively through the judicious use of fertilizers. At this rate the grower would still make substantial profits even if prices dropped to half the present level, because of his greatly increased output. It therefore behoves the State to make available to growers of subsidiary foods, as much nitrogenous and phosphatic fertilizers at reasonable prices as are in demand.

The demand, even at present high prices, far exceeds the supply so far as sulphate of ammonia is concerned. The use of superphosphates and bonemeal is not at present fully understood by the intensive-farming community and demonstrations to indicate their great value will have to be carried out over an appreciable period. It may at first be necessary to subsidize the sale of superphosphate and, in any case, its price must be controlled at a lower level than the present one if the country is to benefit from the large-scale production of both cereal and subsidiary foods. In the absence of adequate supplies of commercial fertilizer, the enterprising grower sometimes resorts to the use of such crude fertilizers as brick-kiln ash. When applied with compost and cattle-dung, very good results are claimed in vegetative growth and in fruit production, especially for *citrus, mango, guava and jackfruit trees. The ash from a* brick-kiln one hundred years old was analysed and was compared with fresh kiln ash. Both showed adequate quantities of plant nutrients, though lacking organic matter. Another source of fertilizer in crude form, for which very satisfactory results are claimed, is the earth from the place where country tanners wash their hides after liming. This earth is said to contain a considerable percentage of lime, some hair, and scrapings of flesh.

The country has a long coastline. Why then are fish not utilized more widely as food and as fertilizer? Fishmeal is both phosphatic and nitrogen-supplying and is as easily manufactured as bonemeal; but there are too few fish caught to make enough of this fertilizer for general use in intensive farming, let alone by the growers of subsidiary foods. (Why also is the Japanese method of raising fish in rice fields not practiced widely?) Papayas and guavas

which should be available to the poorer people in town and village are being sold at exhorbitant prices: The use of phosphatic fertilizers would greatly increase the production of this class of fruit and so bring it within the reach of a wider circle of consumers.

Neither yet has India fully explored the potential sources of phosphatic and potassic fertilizers available in the country. It is time that a commission of experts examined this question, for the country cannot afford to continue importing these fertilizers at present world prices, and the demand must and will increase under the Five Year Plan and after. The State cannot expect the farmer to appreciably increase production if it does not make available to him essential requirements of commercial fertilizer. An expert in the U.S.A. writing on America's dependence on fertilizer says, 'Chemical fertilizers stand between us and hunger.' If that is true of America, how much truer must it be of India, where the food position is already acute?

Soil Response to Fertilizers

A good deal of scientific information is now available about Indian soils which respond well to fertilizers. By far the most valuable work has been done in parts of the Gangetic Plain and is recorded in *Soil Survey and Soil Work in Uttar Pradesh*, volumes I and II, by R. R. Agarwal and C. L. Mehrotra. The soils of the western region of this state have been classified into six types. The characteristics of each type are determined after detailed analysis, and valuable experimental data have been collected, especially in regard to the response of cereal crops to the application of nitrogen as sulphate of ammonia, and phosphoric acid (P_2O_5) as superphosphate. Here are some of the more interesting results:

In the experiments conducted during 1949 to 1951, the value of phosphates for food crops was very thoroughly tested. The value of nitrogen had been known for many years; but so far it was not generally known that the use of phosphates in conjunction with nitrogen could be of very significant value. The average response of crops to phosphates over nitrogen was calculated for Gangetic alluvial soils. The number of trials was large enough to sample the

effects due to the soils themselves as well as to other environmental factors. In the following table an attempt has been made to assemble this information.

Crop	Number of trials	Rates of application in lb. per acre		Yield in lb. per acre		
		Nitrogen	Phosphate	Control	Nitrogen	Nitrogen plus phosphate
Bajra	68	15	15	482	650	766
per cent	—	—	—	100	135	159
Juar	57	15	30	434	564	681
per cent	—	—	—	100	130	157
Maize	17	15	30	504	662	750
per cent	—	—	—	100	131	145
Paddy	4	30	60	1,669	1,785	2,025
per cent	—	—	—	100	107	121
Wheat	210	30	60	1,068	1,373	1,610
per cent	—	—	—	100	129	151
Barley	45	30	60	1,215	1,553	1,963
per cent	—	—	—	100	128	162

The results show that nitrogen and phosphates applied as chemical fertilizers even in small doses increase yields of these cereal crops very significantly. They also show that although nitrogen alone is valuable, when applied with phosphates its effect is even more appreciable. The only possible exception is in the case of paddy, but the soil scientists who conducted these trials are of the opinion that if higher doses of phosphatic fertilizer had been tried with this crop the response would possibly have been much greater. The nitrogen in all cases was applied to the surface soil at sowing time; but the phosphate was applied 3 to 4 inches below the level of the seed sown and to the side of the furrow in which the seed was dropped.

The use of such bulky organic manures as cattle-dung, green manure and compost is of fundamental value. Without the presence in the soil of humus formed from organic matter, the necessary crumb structure, resistant to disintegration by water, is not achieved. J. H. Quastel of McGill University, Montreal, gives in a recent article[1] an excellent analysis of the value of organic matter to soils. According to him, organic matter is primarily derived from the decomposition products of plants and from 'the products of autolysis of the immense numbers of micro-organisms which develop at the expense of substances of plant origin. A dynamic equilibrium exists in the soil between the numbers of bacteria, protozoa, yeasts and fungi etc., that inhabit the soil and the organic matter being continually supplied by the decaying animal and vegetable tissues.' These animal and vegetable tissues are constantly subject to breakdown, but a number of substances resulting from this breakdown are themselves relatively resistant to breakdown. These substances make up in a large measure what is known as organic matter, of which an important product is the black colloidal material known as humus. This substance is important because it 'greatly influences the structure of a soil'. Since upon the structure or clustering of soil particles into aggregates or crumbs depends to a large extent the fertility of a soil, the presence of organic matter is essential for satisfactory crop yields. Organic matter, and especially humus, has a marked influence on the movement of water, air and heat inside the soil. The granular or crumb structure in fertile soils gives them a very large internal surface in which many biochemical and chemical changes take place, adding to the productiveness of the soil. It will thus be evident to the reader why commercial fertilizers should be used on soils which have been treated with bulky organic manures, and why the preservation of all vegetable and animal tissue is essential. These substances should not be burnt or otherwise wasted. They are needed very badly, especially in Indian soils. Wastage of them should be made a punishable offence throughout India, because on them depends in so large a measure the economic strength and stability of the country. And incid-

[1] *Nature*, vol. 171, p. 7 (3 January 1953).

entally, the presence in the soil of organic matter increases, through the process of aggregation of soil particles, the resistance of the soil to erosion.

Soil Conditioning

Recent research has discovered that certain chemicals have a marked effect on the water-holding power and crumb stability of the soil. Such a chemical is sodium alginate, of which 1 per cent added to a poor soil depleted of humus greatly increases its water-holding power as well as its crumb stability, making it as fertile as a garden soil. Such chemicals are known as soil conditioners. They are not plant nutrients, but by altering the structure of the soil they make more water and oxygen available to plant roots.

But work on this important aspect of soil fertility done by Quastel and Webley and confirmed by others has shown that the applied chemical tends to break down rapidly and that as 5 to 10 tons of it are required per acre this may have a harmful effect on the soil. Quastel therefore endeavoured to find a substance or substances which, while improving soil structure, would not break down too soon. Such synthetic soil conditioners have been discovered and are sold under the trade name of 'Krilium'. By this discovery, the possibility of improving fertility in semi-arid waste lands which have suffered through indifferent cultivation or lack of sufficient organic matter, is within sight. Not only are crop yields improved, but the soil conditioner by forming a film permeable to the passage of water, prevents run-off and so protects the soil from erosion. Experiments have shown that adding 1 pound of the conditioner to 100 square feet of soil provides adequate protection to the soil, and an erosion loss of 50 tons of soil per acre can be reduced to a loss of 3 tons per acre.

Experiments in which soil conditioners were applied 'at rates of 0·025 per cent and 0·1 per cent to several saline and alkaline soils produced high water-stable aggregations with considerable increases in permeability of soil'. The effect on crop yields was favourable. On the untreated soils maize gave poor yields, while on the treated soils the quality of the corn was excellent and the yields good. The soil conditioner CRD-186, in other experiments, 'facilitated

removal of salt and exchangeable sodium after irrigation of the soils'. These results are of the utmost importance in that they point the way to reclaiming certain alkaline and saline soils. By the use of soil conditioners it is possible that much of our unproductive soil could be made to yield cereal crops of good quality and in sufficient quantity to more than cover the cost of the process.

On his farm near Lucknow, the writer found that some of his irrigated fields were so porous that the soil would not retain moisture long enough. The texture was sandy and, despite the usual applications of bulky organic manures, the trouble persisted. Eventually a stiff clay was brought from a nearby village and was placed in the irrigation channel leading into these fields. In order that the result could be fairly judged, two adjoining fields of like texture were not so treated. The result within a couple of years was astonishing. The amount of clay applied was so small that it could hardly have amounted to 1 pound per 100 square feet but the two fields so treated improved beyond recognition; while in the adjoining untreated fields the trouble persists. Needless to say, this treatment has been extended to other parts of the farm where it was needed. Here is a cheap soil conditioner which calls for immediate scientific investigation, and if the results confirm the writer's experience, it may save the country the money it would otherwise spend on commercial soil conditioners for this class of soil.

A great deal of information is available on the use of bulky manures and fertilizers to increase crop yields. While research is an unending process and must go on from year to year and from decade to decade, the valuable results of work done over the last fifty years or more should be passed on to the growers of our food crops without any delay. Community projects under the Technical Co-operation Administration scheme already include field demonstrations on the value of manures and fertilizers. A far wider and more determined effort is needed, however, in order that every farmer in each district where irrigation is available may at least be acquainted with the benefits which would accrue to him if he used the appropriate mixtures of bulky manure and fertilizer in the right quantities and in the correct way.

CHAPTER TEN

MECHANIZATION, THE MAN AND THE BULLOCK

A NUMBER of politicians and persons in responsible positions in the Indian administrative machinery firmly believe that mechanization has no place in the rural economy of the country. The emphasis is on the unsuitability of the farm tractor to Indian conditions rather than on any sweeping condemnation of all machinery, and past experience justifies to some extent this point of view. Then there is the question of foreign exchange which limits the import of tractors; there are the further ones of maintenance, service, trained drivers, trained mechanics and spare parts. But there are many instances to show that the tractor has a place in the development of India's resources provided that quick and efficient service is available when breakdowns occur and that reliable and trained mechanics and drivers are available in sufficient numbers, also provided that the tractor is used not to supplant bullock-power and manual labour, but to supplement it.

So far as tractors are concerned, it is appreciated on all hands that lack of foreign exchange limits their import on any considerable scale: Therefore, in this discussion, neither the question of their import nor, indeed, of their supply under any economic aid scheme will be considered. All that matters from our point of view is whether the tractor has or has not an essential place in the drive for increased production. It is left to the reader to judge whether the answer is a definite yes or no, a qualified yes or a qualified no, and to the administration to decide whether or not tractors should be imported.

In the discussion that follows the emphasis is on undeveloped and underdeveloped areas capable of exploitation by a Land Development Corporation or other such state-aided organization. For small holdings, bullock-power must continue to be the mainstay of the Indian cultivator. It is preferable to produce better bullocks and better small

implements for the vast areas which will for many years depend on them than to import tractors, except where large-scale co-operative ventures are proposed.

In the outline of a recent official scheme for the development of a colony of about 100,000 acres, the following is to be found: 'In the colony, detailed experiments can be conducted to ascertain the efficiency and usefulness of (a) tractor ploughing as against bullock ploughing, even with improved implements, (b) seed-drills, (c) harvesters.'

It is obvious that these words were drafted by one who is not well acquainted with tractors, but who has a vague idea that ploughing by tractors *might* be better than ploughing by bullocks. One who appears to have a lurking suspicion that seed-drills and harvesters are worth experimenting with, though it is by no means clear that the power used would be tractors or bullocks.

This sort of nibbling at a subject of national importance cannot take us very far. Why deliberate only on the use of the tractor for ploughing when there are numerous other uses to which it can be put? Why not try to determine once and for all whether the tractor is wanted in India or not and if not, refuse to import any more? But to do this, only one who has studied the subject and understands tractors should say in what respects and with what implements the tractor should be tested against bullock-power which has been the mainstay of the Indian farmer for four thousand years and more. Any Land Development Corporation worth the name should include in its programme the means of securing for the grower-members the maximum benefits of modern farming methods.

'An Inter-State Statutory or Joint-Stock Company with unfettered powers and full freedom of action would have a better chance of producing results than departments of Government are likely to have.' One reason given by the authority from which this is taken is that 'Such a Corporation or Company will be free from red tape and dilatory departmental control.' Quite so, but what does or will any such Corporation or Company want from tractors? The answer is simple and, to some extent, obvious. The Indian farmer must get from the tractor what bullock-power alone cannot provide.

Disc Harrowing

One situation which a tractor can help to meet arises when, after the harvest of India's winter or *rabi* crop, the soil must be opened up by a suitable implement to incorporate the stubble into the surface soil, invigorate fertility, and help to absorb subsequent precipitation. India's bullock-power, after the harvest of the *rabi* crop, is being fully utilized in threshing, by treading the entire harvest, and this takes a long time; for the treading process has to render *bhusa* or trampled straw palatable and attractive as an important bulky food for bullocks and milch cows to last them for the whole year. This trampling requires patience and takes time, and the grower must have it done fairly soon after harvest; otherwise the hot and dry weather causes him loss in weight of grain and strong winds may blow his *bhusa* about and untimely rain spoil it. Of course, the use of a power thresher, run by electricity or an oil-engine, would greatly expedite the process. But even so the straw would have to be turned into *bhusa* with the help of bullocks. Also, it is very doubtful if the bullock-power which could be economically maintained on a 100,000-acre co-operative farm would be able to cope adequately with the post-harvest cultivation of so large an area. And, meanwhile, the fields from which the *rabi* crop has been harvested, are becoming baked and hard and the treading of the grain and straw takes so long that, by the time he is finished, it is generally too late for the cultivator to give these fields any surface cultivation before the rains set in. The first showers run off the surface; the stubble of the recently harvested *rabi* crop is bone dry instead of being worked into the surface soil for use as much needed humus; soil moisture is lost and nitrification is slow instead of being stimulated. Light cultivation by a tractor pulling a disc harrow or similar implement would solve this problem and would improve soil conditions for subsequent crops. The tractor would not have to be heavy- or even medium-weight; one of about 20 H.P. would be suitable. If, however, as has been suggested in an earlier chapter, a really superior job is desired, a sub-soiler would be used and a heavier tractor will generally be necessary; for sub-soiling is profitable where the soil or subsoil or both are clayey in texture. But where the texture

is a loam or light loam, opening up the soil and incorporating the stubble into it could be done sufficiently quickly with the help of a tractor drawing an implement suited to the local soil conditions. In this way 10 to 12 acres per day will be covered without much difficulty; while, with a heavy tractor and sub-soiler on clayey soil, the pace will be much slower and a maximum of about 3 acres is all that one may expect to cover in a day, the blades or prongs of the sub-soiler being fixed $2\frac{1}{2}$ to 3 feet apart. A Land Development Corporation, with the help of a team of 10 or 12 tractors, could therefore lightly cultivate some 5 to 6 thousand acres between harvest and the middle of May, each year.

THRESHING

Having found a use for the tractor in conserving soil fertility, let us see what could be done with one on the threshing floor.

A medium-weight caterpillar type of tractor has been known to complete the threshing of 600 maunds (about 50,000 lb.) of sheaves of wheat and barley within two days, working fairly easily and giving the driver frequent rest periods because of the heat and dust and flying chaff which make the job unpleasant. By this method the grain remains undamaged and the straw is converted into fairly good second quality *bhusa*. Meanwhile, the bullock-power released by the tractor carries out on any land left in stubble, the much desired light cultivation of the fields from which the wheat and barley have just been harvested. Other work will also be found for bullocks at this time of the year; for instance, in ploughing up fields intended for catch crops after the *rabi* harvest. To get prime quality *bhusa* from the tractor-threshed straw, one has only to tread the straw, after it has been winnowed, with bullocks for a day or two. The difference in quality induced by the extra treading is, however, only very small, and this shows what an effective job the tractor is capable of doing. A team of 10 medium-weight tractors could deal with a *rabi* harvest at the rate of 30,000 maunds of grain plus straw per day. As there would be about 75 days available before the monsoon (allowing time for winnowing and bagging the grain and storing the bhusa), this team of 10 medium-weight tractors could

thresh the produce of some 37,500 acres of a good crop of 60 maunds of wheat and barley straw plus grain per acre. The bullock-power thus released over this area would be in the region of 4,000 pairs which, working light cultivators, could cover some 8 to 10 thousand acres per day. Meanwhile, the available labour would be busy winnowing and completing the operation of separating the grain from the *bhusa* and finally in bagging the grain and stacking or storing the *bhusa*. The critic will at once say 'Will not your bullock-power, having finished the surface cultivation of 37,500 acres in 4 or 5 days, be idle for the rest of the hot season?' The answer is a very definite 'no'; for, in the first place, the light cultivation of *rabi* stubble will have to be repeated, particularly if there are pre-monsoon showers in April and May. Secondly, there will be produce to cart to the market, water to draw from wells and tanks for catch crops, and manure to cart and work into the fields by light cultivation. These important pre-monsoon operations are at present neglected because available bullock- and man-power is tied up with threshing and winnowing throughout March, April, May and part of June.

Preparing the Kharif Seed-bed

Let us turn now to the next seasonal operation. The monsoon commences, and a seed-bed for the rainy-season or *kharif* crop has to be prepared and the seed sown as soon as possible. One reason for India's low millet and dry-area maize yield is the inability of the growers with available bullock-power to prepare a suitable seed-bed within the short time usually available, i.e. between the first few showers of rain. A light tractor moving fast, with a cultivating implement in tow, would greatly help in securing a good seed-bed. If the sowing is done by seed-drill, the tractor would be of inestimable value in getting the seed sown within the short time available. Bullock-drawn seed-drills could work side by side with the tractor-drawn drills to get the entire area sown in time.

Making the most of Manpower

We must now decide how to employ the manpower displaced by the use of the tractor. Any labour set free after

the *rabi* harvest but before the *kharif* sowing is over, will be kept more than busy in the work entailed in conserving manure, in making embankments to hold up rainwater and prevent erosion, and in a host of other operations. Incidentally, with tractors in sufficient supply, one or two could perhaps be spared for quickly raising barriers to the flow of water in anticipation of the monsoon. A large single-furrow plough will do this job most effectively and will eliminate unnecessary wastage of manual labour. Men and spades will, however, still be needed to beat the barriers into shape. There is in fact no reason why men should be put out of employment where a tractor is used. Tractors, *supplementing* available bullock- and man-power, can accomplish post-*rabi* harvest operations right up to the sowing of the *kharif* crop and, under intensive-farming conditions, the farmers would be most grateful for some labour to be released during the hot weather for the raising of catch crops of vegetables, chillies and green fodder for their household needs, for milch cattle and for the market. Such fruit trees as papayas, guavas and citrus also need special attention at this time of the year. And under dry-farming conditions the conservation of manure and moisture and the preparatory work of raising or repairing barriers against the flow of water, will require the active attention of any spare labour that there may be at this time of the year. It must also be remembered that thatching of roofs and other building and repair work has to be done before the rains.

Preparing the Rabi Seed-bed

We are now past the opening phase of the monsoon and, except where transplanting of rice has to be done, there is a respite of a week or two wherein men and bullocks rest after the gruelling heat and hard work of the hot weather. Tractors are serviced for the next phase of joint effort—the sowing of the winter or *rabi* crop which is done after a satisfactory seed-bed has been prepared and bulky manure has been applied and thoroughly mixed with the surface soil. Whether it be dry-farming or farming of any degree of intensity, the farmer and his bullocks are now engaged in a race against the time permitted by Nature (during breaks in the rain and immediately after the close of the monsoon),

Transplanting seedlings of rice by the Japanese method, using 2 to 4 seedlings to each hole made by fingers. The roots should be planted straight down. To keep the seedlings 10 inches apart, bamboos are being used instead of string.

A good crop of rice raised under intensive-farming conditions. The liberal use of bulky manure and chemical fertilizer always pays where water is not in short supply.

and generally the race is lost by the grower because he is unable to get a really good seed-bed prepared with the bullock-power at his disposal. With a little help from the tractor, he could ensure a good crop by doing a thorough job of the cultivation necessary before the seed can be sown, and by getting his seed into the soil at the right moment.

It must be borne in mind that a frequently recurring cause of low *rabi* yields is late sowing. Winter sets in and the cold retards growth. There are cloudy days in December and January, followed by some rain. The cloudy weather often persists when the grain in the ears is just beginning to form or has reached the milk stage. Black, orange and yellow rust sets in and damages perhaps 20, 30, 50 or even 80 per cent of the crop. This happens year after year especially in low-lying areas, and, apart from rusts, late sowing lessens the chances of normal plant growth and development. Sometimes, in his anxiety to get his seed sown in time, the farmer will hurry through the seed-bed preparations, and unsatisfactory nitrification and imperfect mixing of the bulky manure with the soil are the chief results. Fortunately this error is not too common; but where an all-out effort is made by the grower to win his race against the time Nature allows him in getting a satisfactory seed-bed prepared, sowing is often delayed far beyond the optimum date. A poor crop is the inevitable result.

A Land Development Corporation that possessed tractors would do well to employ them during the busy season from mid-September to the end of October, for ploughing, discing, cultivating or rolling as may be necessary. Bullocks would still be needed to complete the job. Where weeds abound, a single ploughing by tractor is often all that is necessary to bury them effectively and so destroy them and prevent their reappearance in any quantity during the growing season of the next wheat or barley crop. If weed-infested areas are tackled first and the entire area under the control of the Land Development Corporation is taken up in blocks, as far as available tractor-power will permit, the benefits will be visible in the very first year. A healthy crop freed from the competition of weeds, manured and sown at the optimum time, is rare. With tractors supplementing bullock-power this desirable end will be achieved

without much difficulty and the tractors will still be available for other operations during subsequent seasons.

Other Uses for the Tractor

For the sowing of the winter cereal crop, it will be found that the use of a modern seed-drill drawn by a tractor will not only facilitate timely sowing—for in a single day one tractor-drawn seed-drill will cover 15 to 20 acres—but germination will, under irrigated conditions, generally be much more satisfactory than that obtained by sowing behind the *desi* plough or with the indigenous seed-drills available at the moment. Modern bullock-drawn seed-drills also save seed.

In cases where interline culture under dry-farming conditions is not adopted and where there is no irrigation work to be done, there will be a lull in activity on our tractor-cum-bullock-power co-operative farm, and this will last from the end of the monsoon until the harvest begins in March. This holds good however only if the entire area is set aside for *rabi* cereals. If, on the other hand, potatoes are grown, digging them up with tractor-power supplementing manual labour will get the crop into the market while prices are favourable. Following the lifting of potatoes, the *kharif* crop, which is harvested in October and November, does not usually need the services of a tractor except in preparing the seed-bed. But for post-harvest operations the tractor is again in demand; for if a catch crop is taken during the rains, the field must be prepared quickly for the subsequent *rabi* crop; otherwise it must remain unutilized. Bullock-power is unable to cope with all that the intensive farmer can and must do to make the most of the soil, manure and irrigation available.

An important crop under intensive-farming conditions is sugarcane, and nowhere is the demand for tractors greater than where this crop is raised. Preparation of the seed-bed commences soon after the monsoon and even as late as the end of November, when the potato harvest is over. This applies of course to sugarcane planted in February and March, for it is also planted in October.

Potatoes and sugarcane have been mentioned, not only because of their place in the rotation, but because they are

of importance for another reason, namely their after-effects. The grower of these crops and others like them knows that unless he heavily manures and deeply cultivates his fields, he cannot expect satisfactory returns. The prospect of high prices induces him to put all he can into the preparation of the soil for these very profitable crops. They are his money crops. If he had twice or three times the bulky manure and chemical fertilizer he now possesses, he would give it to these crops; especially if he could obtain the fertilizers at reasonable prices. But to get them properly incorporated into the soil needs deep and thorough cultivation, not always possible with the bullock-power available; nor is it possible, without the help of the tractor, to prepare a sufficiently large area for these crops.

Permanent Improvement

We have seen that after early November, by which time the *rabi* sowings are over, our tractors are comparatively idle. The obvious thing therefore is to employ them in putting as much land as possible under those valuable crops for which deep cultivation and heavy manuring are necessary. This treatment generally results in what is known in scientific farming as permanent improvement. The texture is improved by the thorough and deep cultivation and the heavy manuring; the amount of humus increases; residual or unused chemical fertilizer and bulky manure left by the money crop enriches the soil so that the subsequent cereal crop is greatly benefited. This of course applies to intensive-farming conditions under which a rotation of sugarcane—green leguminous fodder—wheat—green manure—potatoes, or variations thereof is followed. Another rotation could be green manure—potatoes (two crops)—green manure—green legume—wheat. Under dry-farming conditions the rotation will depend on the soil and moisture conditions available.

Harvesting Rabi

To return to our Land Development Corporation's team of tractors, we have harvested our potatoes in November, have prepared our seed-bed for sugarcane and planted it in January and February and March, and our tractors have a

brief respite for servicing and repairs until early March when the *rabi* harvest commences.

A problem now often arises: that of finding enough labour to harvest our wheat and barley before the hot and dry winds of March cause shrivelling of the grain, resulting in a greatly reduced yield. Although no experimental data are available to show what loss in weight occurs in *rabi* cereal grains during the delays caused at harvest due to the inadequacy of labour for harvesting by hand, the farmer knows the devastating effect of the hot and dry weather in March and early April on the weight of his crop. Shrivelled grain fetches a poor price compared with plump grain, and its flour is inferior in quality for making the bread of India—the *chappati* or *rotee*. This applies particularly to late-sown winter cereals.

A quick harvest once the grain is ripe and an equally quick removal of the sheaves from the fields to the threshing floor would be a boon to all farmers in India. The use of harvesting machines worked by tractors and even of reaping machines worked by bullocks would achieve the desired result, without displacing much male labour. Actually it is female labour that is employed far more than male labour for harvesting *rabi*. If India is to raise her standard of living, her women must pay more attention to their homes. If women were released from the necessity of working in the fields at harvest, they could do a variety of things to make their homes more comfortable, more attractive; they could learn how to read and write, or give more attention to such handicrafts as basket-making, embroidery and the like. Here is an opportunity for our Land Development Corporation to set the pace in releasing women from the harvest by employing modern harvesting machines and its team of tractors. The saving in wages and in the amount of gleanings left in the field would earn the farmer-members of the co-operative venture run by our Corporation higher profits. But these should be employed in some measure to compensate those now out of employment and, in fact, to raise the standard of living of the families concerned. A modern harvesting machine can harvest as much as 20 to 25 acres per day. Controlled by a Land Development Corporation of the kind we are considering, 20 such machines

would cover 400 to 500 acres per day or 12,000 to 15,000 acres per month. With trucks or trailers hauled by tractors, a considerable quantity of the harvested crop could be taken to the threshing floors in a few trips, as soon as it is dry enough to thresh. Male and female labour would still be needed to load and unload the sheaves carried by the trailers or trucks to the threshing floors and to spread the sheaves out, if they are to be threshed by tractor-powered treading. Even if stationary threshers are to be used, manual labour will be needed to feed the machines, bag the grain and put away the straw for subsequent treading.

THE DEMAND FOR TRACTORS, AND MEETING IT

In India today, there is no need to create a demand for tractors, or for harvesting and threshing machines. It already exists, and in some places is so keen that the supply is unable to keep pace with it. In Holland, the Netherlands Heath Companie makes a small number of tractors available to several groups of villages. This company, which was 'originally started by private enterprise, is the biggest instrument of the Netherlands Ministry of Agriculture to carry out land development organization and afforestation'. It is run as a commercial concern, charging 10 to 15 per cent plus costs for all work done. In India, private concerns owning tractors are not at present generally willing to undertake contract work. If a Land Development Corporation sponsored by the State were to undertake the risks involved and amalgamate or otherwise organize private ownership of tractors for work on co-operative farms, a solution to the problem of balancing supply and demand would be in sight. The situation would be additionally eased if State-owned tractors (such as those owned by the Central Tractor Organization), were brought in to help tide over the periods of extra heavy demand.

Readers of the foregoing paragraphs will, it is hoped, have reached the conclusion that bullock-power and manual labour need not and should not be displaced by tractors, but that tractors, if used at the right time and for the right jobs, can supplement to great effect the sources of power already available. The large-scale transformation of undeveloped land demands the use of tractors and modern

farm machinery, and this becomes increasingly apparent and of especial interest at this time, when the need for vigorous efforts to increase production has become a matter of paramount national importance and urgency.

Improved Implements

The subject of improved implements and simple machines driven by bullock-power, does not come strictly under the general heading of mechanization and yet it is so relevant as to be worth touching on here. During the past half century, a number of implements and simple machines have been designed to be driven by bullocks. Some of them have been found exceedingly useful and have become so popular that the demand for them far exceeds the supply, which is limited mainly by the shortage of steel. The *desi* or country-made plough, seen everywhere in rural India, is the grower's mainstay. It serves both as plough and as cultivator and yet in the modern scientific sense it is neither the one nor the other. It does not invert the soil, but, in addition to doing the ordinary job of a cultivator, it is heavy enough to press the soil down and so helps to some extent to connect up the moisture in the subsoil with the top soil. Modern agricultural engineers and scientists consider it slow and inadequate for the purposes for which it is employed. There is a strong body of scientific opinion in favour of securing a seed-bed of more or less the same quality for both *kharif* and *rabi* crops (in about half to a third of the time taken in using the *desi* plough), by using a 5-tined cultivator followed by the plank or wooden *pata*, a flat but heavy plank, varying in size, but usually some 8 to 10 inches wide, 4 or 5 inches thick and 8 to 10 feet long. A soil-turning plough would be used once or at most twice, the cultivator twice or three times and the plank after each operation, as is done when the *desi* plough alone is used. This is advocated as the process by which, during breaks in the monsoon and soon after the rains have stopped, preparation should be made for *rabi* sowings. For the *kharif* or monsoon crop, far less effort would be needed. It is, however, not yet experimentally established on any official research station whether the *desi* plough can be eliminated entirely, although certain non-official experts claim that it is

not only possible, but desirable. Normally a good farmer will plough his field with the *desi* plough eight to twelve times before sowing the seed of his winter cereal crop. In any case, the use of a light- or medium-weight soil-turning plough for loams and a heavier plough for clayey soils, followed by a suitable multi-tined cultivator, both drawn by bullocks, saves much time and labour compared with repeated ploughings with the *desi* plough. It would therefore be worthwhile to make available more multi-tined cultivators to meet the growing demand for this class of implement.

Another implement which has found favour with the Indian farmer, particularly in the great Gangetic Plain, is the harrow, which is found in various designs. The harrow drawn over cultivated fields pulls up grass roots and weeds left on and just below the surface during seed-bed preparations. It is also used to break up the crust formed after the first irrigation of wheat and barley and, for this purpose, a peg-tooth harrow in which the pegs can be inclined at an angle is used. The pegs adjusted in this way do not damage the roots of the young plants.

Reference has already been made to the value of bullock-drawn seed-drills of suitable design. These, if available in sufficiently large numbers, would materially help to save seed and to increase our per-acre production of cereal crops. Disc harrows which chop up the surface soil and any stubble or weeds that may be growing on it, are at present available mainly for use with tractors. Bullock-drawn disc harrows have been tried in a few places and with success; they are extremely useful and their mass manufacture should be taken in hand immediately and under proper supervision.

Uneven ground, especially when under irrigation, is one of the most common causes of poor yields. Even under dry conditions, growth is uneven when the field is not level. While in the low lying parts the crop may be satisfactory, on the higher portions lack of sufficient moisture takes heavy toll of it. Hot and dry winds tend to dry up the plants on higher ground when the grain is still green. Under irrigation the effect is worse; for water collects in the low lying parts and chokes the crop which it prevents from getting air. In the higher parts there is insufficient moisture, and a poor yield is the result.

The enterprising farmer therefore tries to level up his fields; the implement most commonly being a metal scoop or *karha* with which he drags quantities of soil from the higher to the lower portions of his fields, this being done during the rainy season when the soil is easy to shift. The scientific way to carry out this operation is to heap up the top soil to one side, plough up the subsoil of the higher ground and remove it to the lower where, in like manner, the surface soil has been heaped to one side. Subsoil thus covers subsoil and the living top soil is preserved as a covering for the subsoil over the whole field. The scoop or *karha* is simple in construction; but chiefly because, owing to the scarcity of sheet iron, it is not manufactured in large enough numbers, it is not in use everywhere.

Bullock- or pony-gears have been proved on some farms to be of immense value in lifting water from tanks or fairly shallow wells, and they are also used to work chaff-cutters and other such machines, being capable of doing a more effective job and at less cost than if manual labour alone were employed to work the machine. As soon as the iron and steel position improves, the manufacture of these gears in larger numbers should receive serious attention. The same applies to bullock-driven water-lifting appliances like the Persian Wheel, especially those of improved design, and to the piston pump, which is worked either by hand or by bullock. All these improved water-lifting devices should be put to officially controlled tests in different parts of India, and the most suitable for each area or tract should be made available to the farmer, and in sufficient numbers. This step would make a substantial difference to crop production which is essentially limited by the quantity of water that can be lifted in an hour. The modern appliance will often raise double or three times the quantity of water lifted by the outdated device.

The Duty of the State

It has become a habit with some people to blame the Indian farmer for the existing backward conditions and for the low yields of food and other crops. The fact should be reiterated that the means of improving his crop production have not always been available in sufficient quantity or at a

reasonable price. For this he is not to blame. Short-sighted policies lacking in practical value have been, among other things, largely responsible for the fact that the manufacture of improved implements for sale at reasonable prices in the villages has received little attention; and without them the farmer has been helpless. Deprived of free and compulsory education, crushed by hunger and poverty and by the many demands made on him under a feudal system, he has been perhaps the most oppressed of all classes of society. Let those in power make up to him in the fullest measure now, what he has been deprived of during the past, and the result will be reflected in a sounder agricultural economy and in adequate food production.

A State-aided but commercially run Land Development Corporation would be in the best position, under present conditions, to bring agricultural production to the desired level. With such an organization, both undeveloped and underdeveloped lands could be made to contribute more substantially to the country's food supplies. The use of tractors and improved and up-to-date machinery and implements would play an important part in the organization's drive for more and better food. The imperative necessity of maintaining adequate servicing facilities for tractors and other machines and of stocking spare parts would, of course, be part of the scheme.

It will be a long time, however, before the individual farmer gets the benefit of such machines and implements unless co-operatives are rapidly organized all over the country. Even when these co-operatives have come into existence, no lasting good will result and the use of improved implements and machines will never be a permanent feature of the country's efforts to meet its food requirements, until there has been organized a vast network of service stations and workshops with trained personnel to go from farm to farm enquiring into the needs of each farmer.

This is not as difficult a matter as would appear at first sight. Hydro-electric power lines already exist in many parts of the country and are being multiplied under the Five Year Plan; in other places Diesel engines can be used to work small generating plants; workshops for State and public transport are to be found throughout the country, and

branches can always be started wherever servicing has to be carried out and spare parts stocked. For the farmers to get the best service from these centres, they should be run on co-operative lines, State-aided to begin with. Unless the Indian farmer is a contributing and not merely an ornamental member (as he so often is), a co-operative will never work smoothly or effectively, for the farmer must feel a sense of personal responsibility for its efficient running. The presence of these centres need not mean that the village blacksmith goes out of business, for he would be trained and employed as part of the centre's personnel. Far from creating unemployment, the scheme would create a big demand for mechanics and the more highly trained agricultural engineers. The village artisan would find employment in these centres in the construction of the various parts of, for example, water-lifting appliances, the actual assembly of which could be done at a central place, rather as watches are made in Switzerland, from the components made piecemeal on a cottage-industry basis.

While the planning and organizing visualized here is taking place, the State should consider seriously the question of importing parts of machines rather than the finished and assembled article. The assembly of parts in India will save the farmer and his co-operatives considerably in costs, for import duty is at present much higher for the assembled machine than for its component parts imported severally. In order to encourage the use of tractors and other foreign machinery for the express purpose of increasing food production, the State must be prepared to forego some of its income from customs duties. Assembly plants, operating under foreign expert aid and with the help of foreign capital if necessary, would be a boon to the farmers of India, and should continue to function until such time as machines and implements of a comparable quality can be manufactured, in their entirety, within the country itself.

CHAPTER ELEVEN

REORGANIZING TO PRODUCE MORE

HAD the present organization dealing with increased food production in India worked satisfactorily, the Grow More Food campaign would have produced more than negligible results. This is not a reflection on any particular administration; it is a surmise based on results achieved during the past decade. The purpose of this book is not to analyse the causes of failure in the past, but rather to specify the kind of organization that is most likely to achieve the best results in the near future.

THE AGRICULTURAL EXTENSION SERVICES

No matter how attractive a scheme may appear on paper, it is the quality and strength of the Agricultural Extension Services that will very largely determine its success or failure. Assuming that the directing authority at the Centre is advised by men of the highest calibre and that the selection of Commissioners of Development and Directors of Extension Services in the various states is based purely on merit, and is irrespective of seniority in service, let us briefly examine the composition of the present set-up in the states and see in what respects it can be brought to the standard necessary for working out in the field the country's most urgent food production schemes.

Starting at village level, the lowest paid officials in the Agricultural Extension Services, usually called *kamdars*, *kamgars* or *mukkadams*, are generally ineffective, both individually and as a team. Lacking in initial training, inadequately supervised and, above all, unwisely selected, these men, with a few exceptions, live for their pay and give their essential work only perfunctory attention. The result is that their presence in the villages is often regarded as a nuisance by the farmers. Instead of commanding respect they are often ridiculed, a state of affairs which is not

conducive to the creation of mutual confidence between this class of official and the farmers whose welfare and interest he is called upon to enhance. Window dressing to satisfy hurried inspections by higher officials is too often the result of this unhappy situation.

The remedy is, first of all, for a team of competent overseers to be selected and appointed to assist the Agricultural Officer in each district in his work of control and supervision. After a brief period of training, this team headed by the District Agricultural Officer should put the *kamdars* of the district through a severe course in effective methods, approved by the Director of Extension Services. The training over, the *kamdars* should be put through a gruelling test in order to ascertain which of them are still incapable of working the sanctioned schemes with efficiency and vigour. Those found wanting must be dismissed without further ado or red-tape delay, as the country's food situation does not permit of leniency. To replace the dismissed men, applications should be invited for the posts falling vacant and the same training and tests imposed so that the best of the trainees can be selected.

As a further insurance against slackness on the part of the *kamdar*, each should be given nominal basic pay only, rather below the minimum cost of living, and bonuses, based entirely on the quality and quantity of the work achieved, up to a maximum to be determined for each state by the government concerned, should be paid quarterly. The bonuses should be graded for first and second rate work, third rate work being considered unworthy of a bonus. Such an approach to the problem will appear severe, but is the only way to get results of any value. Incidentally, it may be found that one first rate *kamdar* is better than two of the second grade and that it is possible to work with a smaller but more effective field staff at reduced cost to the State.

This process of training and selection should also be employed in finding the right type of supervisor or inspector to serve under the District Agricultural Officer, and the selection of the District Agricultural Officer himself should be according to his worth, and not dictated by any other prejudice. Those men with poor records should be compelled

to retire: Others, more active, having the necessary initiative and drive and above all imbued with the spirit of selfless service, must take their place. A useful spur to the efficiency of these officers would be to empower the Director of Extension Services to evaluate, during his periodic inspections, the work of each and to promote or reduce in rank on the basis of his evaluation, without the ordinary process of a charge sheet and all the red-tape delays involved therein. There are at the moment too many official restrictions preventing state administrations from getting the best out of their Agriculture Department chiefs and Directors of Extension Services. The red-tape must be relaxed in the interests of the national drive for self-sufficiency in food. The old order must change, yielding place to the new, if any substantial progress is to be made within a reasonable time.

The present set-up in some states whereby the District Agricultural Officer is placed under a District Planning Officer who in turn is supposed to guide and direct all nation-building activities within the borders of his district, is a bad one. The District Agricultural Officer must not be fettered by interference from the District Planning Officer. The latter may have charge of other nation-building activities, e.g. Co-operation, Public Health and Education, if it is considered desirable that he should; but food production must have top priority, and for this purpose it is most undesirable to have the District Agricultural Officer under any officer other than his own departmental director. The District Magistrate can still be the co-ordinating official for all nation-building activities in his district but, so far as agriculture is concerned, he must, during the present emergency, leave the District Agricultural Officer severely alone and confine his action, on the discovery of any irregularity, to drawing the Director's attention to the matter and advising him to make a personal examination.

To gain the maximum co-operation from district officials of other departments and of all grades at the village level, it would be advisable to hold occasional study groups in which they may be acquainted with the methods of work for increased production and in which local problems may be agreed upon. At these study groups the District Agricultural

Officer should explain in detail the method of approach which he and his staff of supervisors and *kamdars* are busy adopting, showing in the village actual anti-erosion work, moisture and humus conservation, anti-pest measures and other activities. All grades of officials from other nation-building departments must be present, and should be invited to take notes, make observations and put questions. This procedure will enhance the prestige and importance of the food production drive, a prestige which has tended to disappear since it was relegated to a position subordinate to a general planning scheme not primarily devoted to higher food production.

The next question is that of the extent to which non-official support or assistance is needed in working out schemes in the villages; whom to confide in, how much help to expect and what non-official opinion and advice to accept before and during the operation of the scheme.

Farmers in India can be categorized as follows: those who have confidence in government-sponsored schemes for their betterment; those who are indifferent and regard the official as a nuisance, and finally those, who from past experience of incompetent or corrupt *kamdars*, distrust and dislike any official attempt to increase production. Happily the last named are not in the majority; they are in fact the exception. Those indifferent are by far the largest in number, but of the first group there are fortunately a sufficient number to form the backbone of any good State scheme. It is these men who must be taken into the fullest confidence and whose assistance, which will always be gladly given, must be sought not only in working out schemes, but in gaining the confidence of the indifferent or antagonistic elements in the village. They have, however, their own jobs to attend to, and too much should not, in all fairness, be expected of them. They will nevertheless help all they can and it is up to the local agricultural officials to befriend them and enlist their active co-operation.

The co-operation of panchayats (village governing bodies made up of locally elected elders) is also essential to the success of any scheme, and they must therefore be taken into complete confidence. The value and mode of operation of each scheme must be fully explained to them and the more

active and enthusiastic among them should be enlisted to support and help at every turn.

A Land Army

Finally, there are the better educated persons—retired government officials, school teachers, students and political workers—from among whom a body of enthusiasts has to be recruited and organized to assist in official schemes. They will form the nucleus of an organized and trained Land Army. Disciplinary rules and a high standard of efficiency will not be easy to enforce or attain, but without these the utility of the force will be negligible. It should therefore be recruited and organized on the lines of the British war-time Home Guard; pledges taken from each recruit and distinguishing badges worn by them. Transport, food and other facilities must also be provided. Each district should be allotted a brigade or a division, depending on its size, and these should be placed in the charge of a responsible official working under the direction of the District Agricultural Officer, the entire Land Army of each state to be the direct responsibility of the Minister in charge of food production schemes who could work through a Development Commissioner or a Director of Extension Services.

Some idea of the functions of such a Land Army has already been given. These functions will have to be specified, and each will be exclusively concerned with increasing agricultural production. They will ultimately determine what objectives, under each section of the scheme, have to be achieved and in how much time. Setting a time limit will enable the Land Army personnel to adjust their hours of work accordingly; to devote, if necessary, their holidays and their leisure hours.

Once the training period is over, those men and women who are found to be gifted with the greatest capacity for leadership should be put in command of work groups or platoons of the local company, brigade or division of the District Land Army. Delegating responsibility to selected persons within the Land Army will increase the enthusiasm of the mass and should be conducive to effective work. Their efficiency will depend very much on the help and guidance given them by the Extension Services whose

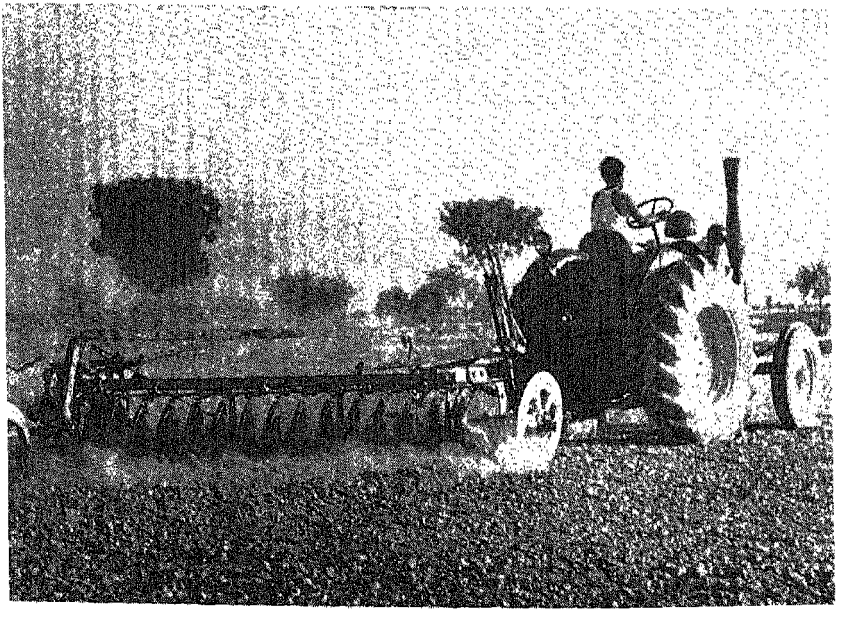
primary responsibility it will be to see that the various schemes, once inaugurated, are run successfully.

Cinemas, schools, the radio, the postal system, the press and every other possible avenue for propaganda should be mobilized to draw pointed attention to the need for a Land Army such as this. Recruiting centres must be opened at as many places as possible, in cities and in rural areas. Pamphlets, explaining precisely the commitment of each recruit and the nation's need of his or her services, should be published and distributed freely. It is not enough for country's leaders to stress in Parliament the gravity of the food situation and the urgent need for food production schemes to be given top priority. The sentiment must become a reality. The need for immediate action must be universally recognized.

Since this was written an announcement has appeared in the *National Herald*, Lucknow, of the steps the Government of Uttar Pradesh is taking to mobilize the manpower of the State. There is in Uttar Pradesh an organization known as the Prantiya Rakshak Dal (P.R.D.), consisting of about half a million volunteers working under the guidance of salaried organizers. The Rakshaks themselves are paid only for each individual job. Then there is the Panchayat Raj Organization, which consists of village committees entrusted with certain powers of self-government within the jurisdiction of their own village or group of villages. Similarly there are Gram Sabhas (local committees) concerned with agricultural development in the villages. To these organizations has been added the whole student community of the State which may be called upon 'to make their contribution to the work of nation building'. According to the official communique, 'The P.R.D., the Panchayat Raj Organization, the Gram Sabhas and the students will be the chief agencies for the mobilization of the whole population.' This is the genesis of a Land Army for the State of Uttar Pradesh; but whether it will be effective in bringing about the revolutionary changes in rural economy which are needed before agricultural production can be increased to the desired level, remains to be seen. Much will depend on how the efforts of this very large body of workers are organized, controlled and fostered. The Commissioner of Development and

Fighting pyrilla, a deadly insect pest of sugarcane, by a modern spraying machine. This pest also attacks wheat and barley.

A disc harrow drawn by a light tractor does a good job quickly, saving valuable time.



Planning of Uttar Pradesh has forwarded the scheme to District Magistrates throughout the State, asking them to maintain and check according to a formula to be supplied to them in due course 'an up-to-date and correct record of the work done on each day and an account of its valuation'. This is an excellent beginning and it is hoped that the rest of India will follow suit.

To summarize the work a Land Army could carry out:

1. Stopping soil erosion by (a) putting up field barriers, (b) gulley plugging, (c) treating hilly ground with clay barriers, (d) planting trees, shrubs and grasses, (e) making broad-based and bench terraces in cultivated riverain and hilly areas and (f) planning drains.

2. Conserving organic and mineral matter. This will entail (a) uprooting and collecting all weeds, especially during the monsoon and before they run to seed, (b) utilizing tank silt, sugarcane trash, ashes, bones, crop stubble, human excreta, village sweepings, urine earth, cattle droppings and manger waste and (c) burying dead animals in such a way that their decayed remains can also be used as fertilizer.

3. Catching and utilizing rainwater by (a) seeing that as much as possible soaks into the soil and subsoil (bunding), (b) deepening tanks, (c) repairing and maintaining water channels, lining them with clay to make them non-porous, (d) deepening, cleaning and maintaining masonry wells, (e) wherever possible, increasing the area under irrigation by *channelling water from streams, lakes and the like and (f)* constructing culverts on village roads to prevent wastage of irrigation water. It is a common sight to see water from irrigation channels spreading out on to country lanes, making cart traffic difficult. The only way to stop this is to construct culverts so that carts can pass over the channels without cutting them up. Culverts will also be required to carry away storm-water which otherwise scours cultivated land.

4. Assist the legislators in the consolidation of holdings by convincing the farmers of the wastage of time and effort caused by having their holdings scattered, and assisting in the more difficult tasks of forming co-operative societies and of arranging for the voluntary exchange of land. Publications of the Food and Agriculture Organization on the

subject and the methods employed in other parts of the world should be studied.

5. Destroying animal, insect and bird pests and supervising the segregation of cattle. Also countering prejudice against the sterilization of unfit cattle. Spraying crops with insecticides and against fungus diseases.

6. Initiating the farmer in the reclamation of alkaline and saline lands and the utilization of waste patches. This will entail a rough initial survey of the available land.

7. Advocating and demonstrating the methods described in chapters seven and nine for improving cereal yields.

A Land Development Corporation

What of the undeveloped lands, fallow lands and vast areas which at present lie idle, but which under scientific treatment would yield very large quantities of rice, wheat, other cereals, and other agricultural produce? These areas run into tens of millions of acres, and there is at present no satisfactory organization which could make them substantially productive in a short time.

Recently, K. M. Munshi, as Minister for Food and Agriculture in the Central Government, conceived the idea of a Land Development Corporation with large statutory powers '*inter alia* to acquire, reclaim and cultivate land; to take land for cultivation on hire, to settle people on land reclaimed; to carry out irrigation projects; to manufacture tractors or provide tractor service; to drill and sink wells and tube wells; to manufacture and improve pumps; to import fertilizers and agricultural implements; to promote and improve forests and tree lands; to establish and conduct appropriate forest extension services; to set up institutions, research stations, workshops and factories, and other consequential and germane matters'. This is more or less the pattern of the Dutch organization known as the Netherlands Heath Companie. In India it would have to be an interstate statutory or joint-stock company with wide powers, and to this reference has already been made. It is suggested that such a Development Corporation could in due course be the national executive for land transformation and that the World Bank would probably be willing to loan the necessary dollar exchange involved. It should not be

difficult for the Government to start the Corporation by loaning the necessary funds. The scheme could probably be financed in sterling exchange from the American Technical and Economic Aid programme.

The Corporation could commence its activities on two or more blocks of 100,000 acres and aim for a small profit margin. With a team of experts directing the Corporation's activities there would be opportunities to train personnel, to make tractors and other machinery available to groups of villages, especially to those in which co-operative farming has been organized. The Heath Companie of Holland before it had its own tractors, took them on hire and used them in this way. It has been the experience of other countries that once a reliable tractor service has been introduced, small farmers, especially those who are members of a co-operative society, become desirous of buying or hiring tractors.

A Land Development Corporation sponsored and aided by the State is more likely to achieve the speedy conversion of waste and underdeveloped lands into areas which can be depended upon for substantial production, than any other agency. This is borne out by experience not only in Holland but, by inference, even in India. In the *tarai* areas of Uttar Pradesh, the Government of that State has been able to develop in a short time a very large tract of malaria-ridden waste land and to develop it at considerable profit to the State. The success of this venture was due very largely to the initiative, energy and drive of one able and enthusiastic officer. Similarly, Dr Dwyf's very large farm in Madhya Bharat has been extraordinarily successful not only in increasing production but in helping to bring into existence a large co-operative society of cultivators. Here again, achievement was largely owing to the initiative and enthusiasm of one man. To find a sufficient number of individuals of this calibre to develop tens of millions of waste land will be extremely difficult; but a Land Development Corporation with definite aims and with a time limit wherein to achieve them, is the type of agency most likely to prove feasible and effective.

It is true that state governments are empowered by the Land Utilization Act to develop waste lands within their respective areas; but past experience has shown that these

powers are not exercised vigorously. The official machine has to face many difficulties both within and outside itself, whereas the type of Corporation visualized here could be authorized by statute to take over on lease and to develop all underdeveloped land, on a small profit basis. The developed areas could then be populated by landless agriculturists on a co-operative footing under State guidance and control. Incidentally, lands so developed would help materially to solve the problem of congestion which results, in certain parts of the country, in holdings that are too small and uneconomical.

Co-operation

Reference has been made to co-operative farming. To organize voluntary collective farming on a co-operative basis or on one of compulsory collective effort is extremely difficult under Indian conditions. Smallholders, especially after their recent legal acquisition of *bhumidari* or proprietary rights, resulting from the abolition of the feudal system, are inclined to be possessive and to resent interference. One of the many redeeming traits of the Indian farmer is however that, despite his conservatism, he will readily adopt anything new of the benefits of which he is convinced. It is entirely a question of how tactfully he is approached by the co-operative and agricultural extension services of the various states. Much patience and wisdom is needed. The idea of co-operating with his neighbour is not foreign to the villager; but to recruit him as an effective member of a village co-operative is another matter.

Co-operatives once organized and successfully worked become the starting point for co-operative farming in a wider and more comprehensive sense. That such co-operatives can be successfully organized is amply illustrated by the example of the sugarcane growers of Uttar Pradesh. The following quotation from a recent account in *The Pioneer*[1] of the development of co-operatives of cane growers in that State is revealing:

'When protection came to the sugar industry about twenty years ago, a large number of sugar factories were started in the United Provinces. They were soon faced with

[1] 20 January 1953.

the problem of getting fresh cane with a high sucrose-content for their requirements, but there was no organization for either the development of cane or its marketing. In this wilderness of chaos, the law of the jungle reigned supreme. Zamindars, money-lenders and even village ruffians acted as purchasing agents and dictated terms to the cultivators. These latter, unorganized, harassed and exploited, were in great distress.

'In 1937, the problem was to mould a primitive agricultural economy to meet the needs of the sugar factories, and protect the interests of the cultivators as well. The Sugar Factories Control Act was passed in 1938, and gave a great fillip to the growth of cane co-operative societies, a few of which had already been started. Areas were demarcated and reserved for the exclusive supply of cane to the factories. It was now essential to organize the growers in the "factory zones" into co-operatives. The Cane Commissioner and his officers bent all their energies to this task.

'He and his band of enthusiasts travelled into every district, organizing co-operatives and preaching in the wilderness as it were, the gospel of "getting together". The response from the villagers was most heartening. They saw in the movement an opportunity to relieve their distress and build the foundations for future improvement in the countryside. But there was hostility from some factories. Attempts were made to wreck the co-operatives; even the law was invoked to challenge the right of cultivators to form co-operative societies. But the movement had already caught the imagination of the cane growers. In 1936 there were 36 cane co-operatives with a membership of 100,000; today there are 110 societies with 1,300,000 members extending to 97 per cent of the factory areas.

'The cane co-operatives were started originally with the object of marketing cane; the development of cane was added to their functions soon after. Today their work has progressed into a village movement—a movement of ordinary people. It has justified its existence and derives its being from the living stream of village surroundings. It now impinges on every aspect of village life, better health, better education and a fuller life. The words "community development" had not then come into vogue, but the

co-operative spirit was permeating the lives of the simple village folk.

'Measures for the development of cane cultivation have included the supply of improved seed, manure and fertilizers, improving irrigation facilities and checking and controlling sugarcane pests and diseases. As a result, the whole State is today covered with cane of improved varieties, the total average distribution being 30 lakh maunds [over 100,000 tons] of seed a year. The cost of manures and fertilizers distributed to the cultivators is now Rs 1 crore [about £750,000] a year. On the irrigation side, 22 tube wells have been sunk in the cane areas in addition to the construction of thousands of masonry wells and the installation of numerous pumping plants and Persian Wheels.'

The funds of this organization have been built up from the contributions of cane growers at the original rate of one quarter of an anna per maund (82 lb.) of cane sold to the factories. This rate has since been increased to three quarters of an anna per maund. A Cane Union's Federation for the entire State of Uttar Pradesh was formed in 1940 with cash reserves amounting to Rs 650,000 (about £49,000), over a third of which will be used to set up its own fertilizer mixture plant. The funds of the co-operatives have been employed for a variety of purposes benefiting the community. Colleges and schools, libraries, hospitals and maternity centres abound within the zones served by the co-operatives. In one factory zone the co-operative has built 122 culverts, 27 bridges and 54 miles of metalled road. Bulk purchase of fertilizers and improved implements for supply to members and a central building, which cost Rs 200,000 (£15,000), housing the Cane Union's Federation's headquarters, are other achievements of note.

This instance of the successful organization and operation of a large co-operative combine, which has provided the means of increasing the per-acre sugarcane yield by 50 per cent, serves to illustrate what might be accomplished among growers of other crops; e.g. of the cotton supplied to ginning factories situated in the cotton-growing areas; of the jute supplied to jute mills within convenient distance of the main jute-growing areas; of tobacco, oilseeds and other crops.

Let the main crops of each area be taken up severally and let co-operatives be organized to market them. The development departments of each state government must be made responsible for mobilizing the manpower necessary for the scheme. Funds can be maintained by the levy of a few annas per maund on each crop selected for marketing; for, by eliminating the middleman's profits, by arranging for better transport, by the mobilization of manpower, the benefits accruing to the grower and to the State would be almost unlimited. And what applies to sugarcane, cotton, jute, oilseeds and tobacco, applies also to wheat, rice, gram, millets and maize, and of course to subsidiary foods like potatoes, groundnuts, green vegetables and fruit.

The middleman need not be thrown out of employment altogether. He can, if he is prepared to accept reasonable remuneration as an employee of a co-operative, still earn a living; but it will no longer be possible for him to become enormously rich at the expense of his less gifted countryman, the tiller of the soil. For, so long as he is organized and assisted by wise statesmanship, it is the grower who will help the nation become economically strong, and not the middleman. Therefore it is to assist the grower and his means of producing food that all organized manpower, official and voluntary, must be directed, if any substantial increase in agricultural production is to be immediately achieved.

CHAPTER TWELVE

LOOKING AHEAD

THE United Nations Survey for 1951-2 shows that India's economic position was worse in that year than it had been in the year 1946-7. Much is expected of the Five Year Plan; but even of that it is said that it will merely succeed in restoring to the nation the living standards of 1939. It is also said that the Plan will not make India entirely self-sufficient in food supplies; although it is expected to go a long way in that direction. But the Plan is to be commended for the many benefits that must accrue from the harnessing of the country's water resources for irrigation and the generation of hydro-electric power; from the development of industry and of the country's rural economy and from the social welfare projects. Nevertheless there can be no lasting economic strength or security, no real prosperity nor any substantial raising of the standards of living in town or village until agricultural production is able to meet all the country's requirements and leave an exportable surplus. To obtain food enough from the land to make India really free from hunger and want, does not lie within the power of the Planning Commission, nor of the Central and state governments, with all their resources of men, money and material. The success of any Plan, in freeing India from want, rests with the people. The nation's mind has to be transformed. Her people's spirit must be awakened. The co-operation of every son and daughter of India is needed if the soil is to be made truly productive.

Under the leadership of the Father of the Nation, India united in the struggle for independence from foreign domination. But India is not free and never will be until with the same spirit of self-sacrifice her peoples unite in the war against want. When our vast population has been adequately fed and clothed, will be time enough to tackle the question of a higher standard of living. Indeed, the achievement of the one is a prelude to the achievement of the other. To see

that our cattle, sheep and goats have enough to eat and are not forced to wander about destroying our crops, our grazing areas and our young forests, that our best bulls and cows are used for breeding and the useless ones sterilized, will be the first step towards providing really first rate milch cattle, and so seeing that every household in the country has enough milk and butter to consume. When we have increased our wool and cotton production by 50 per cent, will be time enough to talk of having clothing for all. The possession of trees in number sufficient to attract rain and prevent erosion, and also to provide wood for fuel and for better houses and furniture, will in itself constitute an appreciable advance in standards of living. More bicycles, more radios, more motor-cars and more refrigerators, will all follow in the course of time; and very quickly once so much has been produced that there is an exportable surplus with which the country can buy them.

Many attempts have been made in the past half century to raise the standard of living of the rural masses. Brayne's efforts in South Punjab succeeded only after he had become head of a district and was able to impose his ideas on the farmers with whom he came into contact. When he left, the farmers seemed to lose whatever interest he had aroused in better ventilated houses and in the many other amenities which formed the objectives of his project. Other visionaries have attempted the same thing, and so long as they are on the spot it seems to work well enough. But in nearly all cases it is putting the cart before the horse and, because it makes him little or no better off financially, the farmer is not really interested in spending any of his savings on better housing. Double the farmer's yields, save his fields from erosion and his crops from pests, get him a fair price for his produce by means of co-operative marketing and get him his necessities at reasonable prices through co-operative buying, and he will be more ready to fall in with plans for improved housing, educational facilities and the various other schemes to make his lot a happier one.

JOINT EFFORT

One of the most hopeful signs of the times here in India is that there are thousands of men and women, young and

old, who are prepared to give up some of their leisure for service to their motherland. On Republic Day, the 26th of January 1953, manpower in the State of Uttar Pradesh was mobilized in 36,000 villages, or about a third of the total number of villages in the State. The chief object was to make roads to improve rural communications; but it also set a wonderful example to the whole country. What was achieved in one village, Bhagwanpur, of 2,500 inhabitants, in the district of Saharanpur is worth relating. The villagers formed themselves into a small Land Army unit. In ten days they set up 2 buildings, constructed 440 yards of road 22 feet wide and 2½ feet high, constructed another half mile of road with 3 culverts and a village hall. They repaired or dug several wells, soakage pits and compost pits, removed and utilized 200 manure heaps, repaired and cleaned 500 yards of drain; bored and constructed several latrines and cleaned and repaired all the lanes in the village. Here was work of real national utility. The spirit in which it was done is the spirit it is possible to instil in all the villages of India.

If the young students of our universities and schools were to unite in helping to organize units such as this, the future of an effective Land Army in India would be assured and the battle against want would have been started in earnest. For, once an embryonic Land Army has begun to function, it is to be hoped that the patriotic spirit of selfless service will spread. There are, from present indications, millions of volunteers available for service throughout India, and the question of training and directing this formidable force into those channels where it is most urgently needed, is one which requires the most careful thought. Constructing unmetalled village roads, cleaning up villages and constructing new buildings are all commendable activities, but in themselves will have little direct effect on increased production of food. The Central and state governments would therefore do well to consider some form of organized training, to be carried on concurrently with any other activity in which the Land Army may for the time being be engaged. Elsewhere in this discussion, the desirability of organizing training centres or camps and of making a rough survey of the needs of each area, before commencing work thereon, has been emphasized. In addition to this, immediate atten-

tion must be paid to propagating the values of higher production to all volunteers. All educational institutions, from village primary school to the degree college, must commence giving students a clear and visual idea of all that higher agricultural production implies, and it should not be difficult to incorporate the subject into existing curricula.

TRAINING FOR THE LAND

Every educational institution, no matter how small, has a few square yards of land attached to it. Some have several acres. To begin with, let each institution set aside a minimum of 10 square yards—5 × 2—for the visual demonstration of what happens to a cereal crop like wheat, rice or barley when given a good seed-bed, plenty of manure and plenty of water. Two plots, each about 5 square yards in area and separated from each other by a yard or so, should be dug up, manured, sown and watered and finally harvested and threshed by the students. One plot would be given an average dose of manure, bulky compost or cattle-dung, and fertilizer, and the other would get a calculated extra heavy dose of sulphate of ammonia, and double that dose of superphosphate ($P_2 O_5$), together with a basal dressing of bulky manure. The local agricultural expert could work out the actual quantities required for the most spectacular results. The plots would be so small that the cost of raising the cereal crop thereon would be negligible. The student's interest would be freshly aroused at each stage of the process of cultivation. The size of each plot being roughly 1/1000th of an acre, comparisons would be made easy—4·84 square yards being exactly equal to a thousandth of an acre. The unusually heavy crop of cereal obtained by the heavy dosage of manure and fertilizer would be a sight to convince the student of its value when applied over many acres. The local agricultural expert should visit the institution from time to time and explain the implications of this cheap and simple process of heavy manuring and how organic manure can be augmented. If night soil from the school or college latrine is used, the double achievement of securing bulky organic manure of high fertilizing value and gradually removing prejudice against handling it after the normal period of pitting, will be served. For institutions

which can afford a more elaborate demonstration, several such plots, each having a different food crop growing on it, will provide even greater interest and incentive. Gradually, as circumstances permit, other visual aids to understanding the problems confronting the country can be included in the project. For example, simple methods of preventing soil erosion; of growing subsidiary food crops like potatoes, sweet potatoes, tapioca, colocasia and so forth, with and without extra heavy manuring; utilizing green weeds and other rubbish for making compost; improving waste land by planting trees, and reclaiming alkaline land, can all be demonstrated without making the curricula too cumbersome.

Pamphlets written in simple language, explaining these problems and showing how they can be solved with the help of voluntary service, should be made available in schools, colleges and in all rural and town libraries; talks by knowledgeable and enthusiastic leaders, given from time to time at all educational institutions, especially in the rural areas, will help the cause; the cinema, the radio and the stage should be used frequently and engagingly. In colleges and universities, in clubs and social welfare societies, debates, lectures and discussions should be organized on such subjects as: Is it right that prejudice against handling night soil should prevent India growing enough food for her underfed people? Should sterilization of useless cattle be enforced? How far can either artificial insemination or sterilization of unfit livestock meet the country's need for better milch and draft cattle? The list could be made a comprehensive one by the inclusion of subjects such as the sterilization of persons who can only produce diseased or mentally deformed progeny, an argument that found favour in certain parts of the world not so long ago; for such subjects of social and economic interest as family planning, which directly concern the nation's responsibility to present and future generations, should be discussed more frequently and from the highest intellectual platforms in the land.

Closer and more friendly contact between the more educated people of the cities and their less fortunate brethren in the villages is urgently needed, if scientific knowledge is ever to reach the masses. The Indian villager is by nature a hospitable and kindly person. The townsman need not fear

that he will be unwelcome in the village if he goes there for the purpose of informal lectures and friendly talks. So very much can be done by this sort of contact that snobbishness on the part of the townsman is unforgivable, as it will destroy the respect and trust of the other.

What of the numerous agricultural schools and colleges that have sprung up so rapidly within the past forty or fifty years? If the syllabus of courses of the majority of these institutions is scrutinized, it will be found that far too little time is left for *practical* instruction in farming. Such subjects as chemistry, physics, botany, zoology, entomology, plant pathology and veterinary science seem to get more than their fair share of attention. The result is that graduates or diplomats from these places of instruction are rarely properly equipped for leadership in the struggle for self-sufficiency in food. Either too much emphasis is on the basic sciences, or the practical instruction is faulty or it may be that the ambition of the student is too narrow. Whatever the cause may be, it is high time that it was eliminated; and, in this connexion, the Report of the Agricultural Reorganization Committee of the United Provinces (1938-9) will be found to contain much wisdom and many useful suggestions for overhauling the present system of agricultural education in India. The Report deals, among other things, with the all-important question of giving education in rural areas an agricultural bias from the very start. It also discusses in detail what might be called a sound syllabus of courses for agricultural schools and colleges.

LAND SCHOOLS

Recently, in one State at least, the idea of starting a chain of Land Schools for the sons and dependents of the ex-servicemen who fought in World War II, has taken root. The main purpose is apparently to train these boys to like agriculture for itself rather than to pass examinations for the sole purpose of securing a job. No young man will be attracted to a profession which does not pay: It follows therefore that to make farming attractive as a profession, the youthful entrants to these Land Schools must be shown how very paying the art of farming can be. For they have

to imbibe the science and art of the profession as part of themselves, and this they will do only if it is proved to their satisfaction that they can make a good living out of it. With the high prices that agricultural produce can at present fetch, there is no question but that farming can and does pay handsomely, if practiced with common sense and the necessary practical knowledge. It is this *practical* knowledge that must be imparted in all agricultural schools as thoroughly as possible. For theory, lectures for an hour or two hours a day only should suffice, and this will enable the student to devote practically all his time to field operations. The school farm must have livestock, and the students, who must do all operations with their own hands, should experience each of the activities of a normal working day. All good farmers rise very early to attend to the cleaning of cattle sheds, milking and feeding of cows and buffaloes, and at some seasons they commence ploughing while the ground is still wet with dew. Land School students must start work at dawn and stop at dusk, with a break during the day for the midday meal and rest. They should breakfast in the fields while at work, as most good farmers do, so that there is no unnecessary loss of time. The school farm should be divided into plots of five or six acres, each corresponding to the unit most easily managed with a pair of average bullocks under intensive-farming conditions. Each unit should be amply irrigated, and should be farmed by a group of boys, the number being determined by the size of the unit. At Anand in Bombay State there is a privately run agricultural institute where the unit is 5 acres and each unit is managed by a group of 5 boys who are said to make an average income between them of Rs 250 (about £19) a month by farming it. For Indian conditions this is a fair income; but considerably higher incomes could be earned from each unit with the adoption of really intensive methods, examples of which could be taken from the phenomenal yields of wheat, rice, maize, gram, potatoes and millet obtained by entrants in the crop competitions held in recent years by the Indian Government.

If our Land Schools and other agricultural institutions wish to make a really good impression on the minds of young farmers and of older and more experienced men in

the profession, they must produce these substantial yields. Competitions should be held and handsome prizes given to groups producing the best results; and the competitors should study the methods employed by prize-winners in the all-India crop competitions. Those applicable to the area should be adopted; the cost to be met by loan to the students, recoverable from the proceeds of sale of their crops. For example, an acre of wheat yielding 5,000 lb. of grain and 8,000 lb. of *bhusa* or trampled straw, valued greatly as a bulky feed for work and milch cattle, would represent roughly the following gross income:

5,000 lb. of wheat at Rs 21 per 100 lb.	Rs 1,050
8,000 lb. of *bhusa* at Rs 4 per 100 lb.	,, 320
Total ..	Rs 1,370 per acre

(These yields are less than the highest actually secured in the Indian crop competitions.)

Against this income must be set off expenditure on fertilizer, bulky manure and the time spent on field operations. In actual cash this may be as high as Rs 500, depending on the cost of fertilizer and bulky manure, all labour of course being supplied by the students themselves.

In the case of potatoes, by deeply ploughing the land and applying very heavy doses of both bulky organic manure and commercial fertilizer, it should be quite possible to obtain a yield of 500 maunds (41,000 lb.) per acre. At the average price of Rs 6 per maund usually prevailing at harvest, gross receipts would be Rs 3,000 from one acre. Expenditure on the main items of seed, bulky manure and fertilizers may, in this case, be as high as Rs 1,400; but even so the students, after allowing for labour and cultivation costs, would be left with a handsome net profit. The same applies to sweet potatoes and other cash crops which are also subsidiary foods. It is therefore worthwhile setting out to secure the highest yield per acre for all crops grown; only then will young people realize the prospect of earning a substantial living from farming and of assisting the national cause in the process.

The courses of instruction in Land Schools should include only the essential minimum of scientific training: Practical agriculture must take priority over all other work. A good library would be a great asset to an institution of this kind; for an hour a day spent in regulated and controlled study under a competent teacher is, as a rule, worth much more than the time spent in the lecture room. Practical training in the following must form part of the syllabus: artificial insemination; immunization of cattle against such serious diseases as rinderpest; sterilization of useless cattle; methods of fighting crop diseases and crop pests; the use of soil conditioners such as 'Krilium' in reclaiming and improving soil, and of soil-binders in checking erosion; the kind of trees that do well as wind-breaks and those which thrive under dry conditions; desert control; the mixing and application of the different kinds of chemical fertilizer; the value of modern farm implements and machinery, their adjustment, care and use; fruit and vegetable farming; controlled grazing and the value of legumes as cattle-feed; the place of oilseeds and fibres in Indian farming; dry farming and methods of controlling and conserving run-off rainwater; the care of milch and work cattle; crop rotations.

The general purpose farm of the institution should have a small but competently run fruit and vegetable plot. On this plot should be taught the practical aspects of horticulture and, in particular, such matters as raising nurseries and grafts, and utilizing the space between rows of fruit trees for vegetables, until the trees grow so tall that vegetable culture on the same land is no longer possible. Seed selection and storage for all crops should be part of the practical course, and underground and surface cement storehouses of dimensions to suit village conditions, should be constructed.

Co-operation

Two subjects of the greatest importance to the development of our rural economy and to neither of which has sufficient attention been paid so far, are those of co-operative credit in particular and of rural co-operative effort in general. Professor H. L. Kaji has made the following observation on the subject, one which is very much to the point: 'Co-operation has so long been a protest against exploita-

tion, an attempt at the elimination of unnecessary middlemen between producers and consumers, an effort to improve the economic condition of the small men in urban and rural areas. But it has not been tried as the economic structure of society.' To anyone acquainted with marketing conditions in rural India it will be obvious that the first and most urgent step is to organize growers' co-operatives on the lines of the sugarcane growers' in Uttar Pradesh during World War II.

Many further instructive examples could be quoted from the experience of other countries in developing co-operative activities in rural areas. A striking example of governmental initiative in inaugurating a scheme to benefit unemployed persons with agricultural experience and some capital of their own, is to be found in The Land Settlement Association Limited of England whose headquarters are at 43, Cromwell Road, London S.W.7. This Association was formed during the depression of 1934 for the purpose of buying estates and laying them out as small holdings. Most of the capital required was advanced by the Government, but some was contributed by the Carnegie Trust and by private individuals. In this scheme shareholders are not permitted to earn profits, but each holding is 'designed to provide a good living for a capable tenant', the size of the holdings being from 2 to 10 acres. In 1952 there were 19 developed estates belonging to the Association, each consisting of a group of small holdings, the largest of over 100.

Bulk trading, buying and selling for the tenants on each estate, is organized centrally by the Association. The tenants are charged reasonable current rates for the services rendered to each of them. 'It is a condition of tenancy that all tenants co-operate in these arrangements in order to ensure economic working.' Thus a great volume of business passes between the Association and its tenants who are paid the proceeds of the produce marketed on their behalf by the Association. The tenants in their turn pay for the supply of their day-to-day requirements of manures, seeds, equipment, tools, etc. 'Accounts for all these transactions are presented to the tenants and a net settlement is made once a month.' The Association does not interfere unduly with the tenant in the farming of his holding, although the tenant is bound

by agreement 'to conform to a general plan of production in respect of the cropping and stocking of the holding'.

The tenants have formed a national association with branches on nearly every estate. There are regular consultations between the management and the representatives of the tenants 'on all matters affecting the tenant's interests'.

The amount of capital required to take over and work a holding varies between £1,400 and £1,800, but the Ministry of Agriculture and Fisheries, which owns the holdings, lends on easy repayment terms and at reasonable rates of interest up to three quarters of the capital required.

The writer had occasion in 1946 to visit one of the estates of this Association at Fen Drayton in Cambridgeshire. This estate was at that time divided into two parts, (i) 230 acres settled with tenants holding 3 to 5 acres each and (ii) 70 acres of the poorest land farmed by the management whose salaries were met from the profits of farming it. All the tenants, mostly unemployed ex-soldiers, had some previous experience of farming. Their holdings were very intensively farmed, green vegetables, potatoes and onions being the chief crops grown—some being raised under glass. Each tenant was required to maintain some livestock. The holdings being too small for dairy cattle, the livestock consisted mostly of goats, pigs and poultry. Between 1939 and 1945 the value of the tenants' holdings rose from £11,000 to £78,000. The weight of the output in the same period increased 3 to 4 times.

The tenants got the grower's price for their output without having to take their produce to the market. The management made a nominal charge for transport, containers etc. This was not a direct charge but was taken from the profit made on stores supplied to tenants and on packing-shed transactions. The marketing costs for neighbouring non-member farmers was 14 to 20 per cent as against 7 per cent for tenants of the Association whose produce was always in demand and fetched better prices because it was graded. This 7 per cent covered grading, packing, carriage and overheads. Depreciation on packing cases, sacks, trucks etc. was charged to profits on stores. The tenant members had no packing cases or sacks to bother about because they got these on loan from the Association.

The houses provided for the tenants were comfortable, containing four main rooms each and all modern facilities. The occupants seemed contended and prosperous. The equipment maintained by the management included several tractors which were used for all major cultivation. The ploughing charge in 1946 was 10 shillings an hour, which worked out at about Rs 13 per acre. Seed-drills, cabbage transplanters, potato diggers and rubber-tyred carts were among the equipment available to the tenants. The cabbage planters were capable of transplanting five acres of seedlings in one and three quarter days. This is much quicker than hand planting, and it is also more effective in that the roots are kept straight and the plants get a better start. The tenants utilized some of their spare time in making compost from vegetable and animal waste matter.

The Fen Drayton Scheme is a striking example of the success of co-operative principles carried out on the initiative of a government for the benefit of the unemployed. It has much to teach administrators, extension services and, especially, the young and enthusiastic students of land schools and agricultural colleges in India. Training on an estate such as this should prove of value to teachers and others interested in resettlement and the simultaneous development of those large tracts of land which are at present either underdeveloped or undeveloped. The significance of this experiment is not only for India, but for the whole of South-east Asia. The difference between a co-operative society of small-holders and the Fen Drayton estate managed by a State-aided organization lies only in the fact that the affairs of the latter are run by a limited company under the guidance of a government. Under rural conditions in India at present pertaining, to expect groups of a hundred or more tenants to run successfully a co-operative farming concern by themselves is to expect a miracle. But aided by expert knowledge and supervision, funds and management, provided by a wise government, there is every chance not only of profitable farming but of developing and transforming pockets of undeveloped or underdeveloped land throughout the country.

Acharya Vinoba Bhave, a disciple of Mahatma Gandhi, has for some time been touring the country securing voluntary

gifts of land from those who possess more than they need, in order to provide land for unemployed and landless labour. His efforts have so far met with a certain amount of success; but once this movement, known as 'Bhoodan Yagna', has secured gifts amounting to millions of acres, as it is quite likely to do, the question on everyone's lips will be 'What next?'. The answer is supplied by the successful working of organizations such as the Fen Drayton estate, and it would be wrong to say that conditions in rural England are so different from those in Asia that emulation is useless. The initiative must, in the first instance, be taken by the State. The framers of the Indian Five-Year Plan should study carefully the organization and working of the Land Settlement Association Ltd, for it is possible that more good would come from a scheme such as this than from all the present rural development projects put together.

There are today 173,000 co-operative societies in the country with a membership of 12 millions and a working capital of Rs 233 crores (about £175 millions); but how many can be said to work as efficiently as the estate described above? It is not the number of co-operatives, but the efficiency with which they work, that will count in the future. A Land Development Corporation such as that visualized in chapter eleven would be a model training centre for co-operatives of the Fen Drayton type. Only when co-operatives of quality have been started can their value become apparent to trainees, and inspire in them the ambition to see a co-operative movement transforming the rural economy of the entire Indian sub-continent: For it is only by the efforts of those who realize the value of it will the movement thrive; not by the abortive activities of window dressers of whom there are far too many. Here is what the Indian delegation to Palestine had to say on the lesson co-operative farming in that country has for India: 'Apart from the farmer and his land and capital resources, the most important factor which would determine the extent of success or failure in co-operative farming and marketing would be the public or governmental agency entrusted with this work. No amount of expenditure would assist if officers and others in charge of this task act in a mercenary manner. Every one of them must take this

as their life's mission to be performed for the good of the country with the greatest possible zeal and honest effort.'

Co-operative Credit

So far as credit is concerned, the Reserve Bank of India can lend money to scheduled or co-operative banks, but not to the grower direct. The farmer has therefore to borrow from the co-operative banks; but as an individual he has little or no security to offer. Organize the small farmers into co-operatives of the Fen Drayton type and you have an organization to which any bank would be glad to lend money on reasonable terms. There are at present three kinds of loan: short-, medium- and long-term. Of these, short-term credit is most in demand and happens to be the most effective in bringing quick results by increased production, in farming and in cottage industries. It is to be hoped that the Bill, now before Parliament, to amend the Reserve Bank of India will be so revised as to treat cottage industries and agriculture more or less equally in the matter of credit. For the growth of India's economic strength in the years immediately following the attainment of self-sufficiency in food will depend very largely on how wisely industry is decentralized. That cottage industries can play an important part in national economic development is amply evident from the experience of other countries, especially Switzerland, where the world-famous watch industry is organized on these lines; workers in rural areas making the various parts of the watches which are then assembled at the industry's various urban headquarters.

At present, out of India's vast population, less than 3 million persons are employed in industry. In our dry-farming belts, farmers have ample time to engage in cottage industries. One of our greatest national assets, abundant manpower, has not yet been organized, although mobilization of a small part of it for certain aspects of rural development has now begun, and this is all to the good. But if any large section of society is idle for long periods, it is bound to have undesirable effects on the national economy and, in our case, scores of millions of people are available for mobilization and await training, equipment and organization.

Inflationary prices have created a certain amount of capital, not perhaps with the small farmers, but certainly with the larger farmers who grow cash crops, with village bankers or money-lenders, and with the numerous artisans such as village blacksmiths, carpenters, oil extractors and others. For co-operative societies in rural areas, therefore, capital should be forthcoming in the first instance from the village itself. Once a society has been properly organized, co-operative banks will supply all the capital needed for the development of cottage industries and for supplies and co-operative marketing. The first step is, however, for the State to instil a feeling of security and confidence in the minds of prospective members and to provide an efficient system of guidance and supervision by selfless workers. For village co-operative credit societies, the State must, therefore, in the initial stages of their formation, stand surety for money advanced to them by banks. It must boldly declare that in the event of a village co-operative credit society going into liquidation, it will immediately pay off the creditors before taking action against defaulting members. Once confidence has been so created, the necessity of the State fulfilling such a declared obligation will seldom, if ever, arise. In each district there should be one central co-operative bank with adequate working and owned capital, branches of which can always be opened where and when they are required. A stringent audit of the accounts of rural credit societies is most necessary, and the management of the central banks and of their branches must on no account be influenced by non-rural interests. Someone has very wisely said that politicians in power who say that co-operation is above politics should also see to it that in actual practice nobody plays politics with its policy or personnel.

Seed Supply

One field of activity in which co-operative effort has been entirely absent in the past is in supplying certified seeds of a superior quality and purity to farmers throughout the country. Reliable seed farmers are the exception rather than the rule. The present system under which the State has undertaken seed supply, has failed to provide the farmer with anything like adequate supplies and has cost an

enormous sum of money in maintaining seed stores and the necessary staff to run them. In other countries the farmer seldom has any difficulty in securing his seed from private agencies which do a flourishing trade in growing and supplying certified seed. In Lubbock, Texas, the writer, in 1946, came across a farmer who was selling certified seed barley at 7½ cents a pound against the market price of 3 cents a pound for ordinary uncertified seed. Other farmers seemed glad enough to buy really good seed at this premium price which was 150 per cent higher than the price of ordinary seed. State Agricultural Departments in India would do well to organize selected farmers into registered co-operatives for the express purpose of growing and supplying superior quality seed to farmers of the neighbourhood. Capital would be needed to build seed depots and to bear the initial cost of running the business, but the premium charged for the superior seed should more than cover this; for superior seed generally accounts for an increase in yield of from 15 to 20 per cent in the case of cereals and more in the case of such cash crops as sugarcane, tobacco, cotton and potatoes.

Is it too much to expect that the present generation devote some of its time and energy to organizing rural co-operatives? Many of us have welcomed the Five-Year Plan and have resolved to do our utmost to make it a success. Here is what the framers of that Plan have to say about co-operation: 'When individualism was the order of the day, co-operation represented a defensive act. But with the adoption of the principle of social regulation, co-operative societies have a more positive role. In a regime of planned development, co-operation is an instrument which, while retaining some of the advantages of decentralization and local initiative, will yet serve willingly and readily the overall purposes and directives of the Plan.' The value of co-operation has not yet been fully grasped in India: It is essential that it should be grasped, and without delay.

And not only have we to help make the Five-Year Plan a success, we have to do more than that: We have to make India prosperous by producing enough to export. That this can be achieved there is no doubt, provided there are enough men and women who are prepared to work selflessly to this end. Well organized village co-operatives are going to play

a very important part, for 'only in co-operation is there any real hope for peace, contentment and happiness. Co-operation welcomes the capitalist, though it eschews capitalism; co-operation welcomes labour and recognizes its just claims, but rejects its attempt at domination; co-operation welcomes the consumer and concedes his rights, but rejects efforts to exploit the worker in productive enterprises. Justice, equity and fair play are the hall mark of co-operation.'

THE BEGINNING

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